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ORIGINAL ARTICLES.

I.—Sedgwick Museum Notes: New Fossils from the Haverfordwest District. VIII.

By F. R. Cowper Reed, M.A., F.G.S.

(PLATE XIV.)

Typhloniscus princeps, sp. nov. (Pl. XIV, Figs. 1–3.)

Head-shield broadly semicircular, gently convex; posterior margin nearly straight; middle shield projecting slightly in front of cheeks, and rather bent down. Glabella subquadrate, length slightly greater than width, front truncate, nearly parallel-sided, widening a little anteriorly to maximum across first lateral lobes, moderately convex from side to side, rising gradually in height from back to front, where it is somewhat swollen and slightly overhangs anterior margin of head-shield; sides marked with three pairs of regular, subparallel, subequal, and nearly equidistant, strong lateral furrows; anterior pair nearly straight, directed a little obliquely backwards, and extending inwards for about one-third the width of the glabella, situated far forward at about one-fourth the length of the glabella, and a little in front of the point of junction of the axial and marginal furrows; frontal lobe short, broad; second pair of lateral furrows nearly straight, arising a little in front of middle of glabella, running inwards parallel to first pair, but a little longer; first lateral lobes with parallel sides; third or basal pair of furrows with inner portion curved back, but not reaching occipital furrow; second lateral lobes of same length along axial furrow as first pair; basal lobes subrhomboidal, rather less than one-third the width of the glabella. Occipital furrow strong, arched forward slightly in middle and at sides. Occipital ring rounded, rather narrow, a little wider in middle. Surface of glabella and occipital ring ornamented with rather coarse tubercles, with smaller ones interspersed. Axial furrows strong, straight, meeting marginal furrows at right angles a little behind first lateral furrows of glabella.

Cheeks triangular, rather wider than glabella, moderately and uniformly swollen, without eyes or facial sutures, ornamented with tubercles like the glabella, and, in addition, with coarse circular

pittings. Neck-segment convex, rounded, widening slightly towards genal angle, where it markedly broadens and passes into similarly rounded lateral border. Neck-furrow strong, slightly sinuous, bending forward towards genal angle and uniting with marginal furrow in sharp curve. Lateral border of same general width as neck-segment, but widening somewhat at lateral angles of frontal lobe of glabella, where it passes into pre-glabellar border. Genal angle provided with stout, slowly tapering, rounded spine, projecting outwards and backwards at about 135° to posterior margin, and probably half as long as head-shield. Marginal furrow strong, meeting axial furrow at right angles. Narrow rounded border in front of glabella, separated off by strong marginal groove containing small deep pit on each side of lateral angles of frontal lobe. Neck-segment, genal spine, lateral and pre-glabellar borders ornamented with tubercles like glabella. Thorax and pygidium unknown.

Dimensions :—

	mm.
Length of head-shield	18·0
Width of head-shield	47·0
Width of glabella at base	14·0
Width of glabella across first lateral lobes	16·5
Length of axial furrows	13·0
Width of cheek	16·5

Horizon and Locality.—Sholeshook Limestone: Sholeshook railway cutting, Haverfordwest.

Remarks.—The only species of this genus previously described comes from the Bokkeveld (Devonian) Beds of South Africa, and is likewise only known by head-shields, and it is consequently a surprise to find the genus represented in Ordovician rocks. But there can be no doubt that this Sholeshook trilobite is referable to the genus *Typhloniscus*, which Salter recognised belonged to the Cheiruridæ. The Cape species, *T. Baini*,[1] Salter, differs from ours in having the glabella of a trapezoidal shape, and in the less developed and rather differently directed lateral furrows; the genal spines are also much less strong. But the general characters of the head-shield and typical Cheirurid ornamentation of the cheeks, and most particularly the absence of eyes and facial sutures, indicate their affinities. The blindness of this genus must be regarded as significant of special adaptation, and is not a primitive feature, as the author has previously pointed out.[2] Another blind member of the Cheiruridæ is found in the Ordovician of the Himalayas, and was described by Salter[3] as *Prosopiscus mimus*, but our Sholeshook form cannot be referred to the same genus.

Zygospira Haswelli, sp. nov. (Pl. XIV, Figs. 4–9.)

Shell transversely elliptical to subcircular, biconvex. Pedicle-valve slightly more convex than brachial valve, usually with a shallow, indefinite, broad median sinus near anterior margin; umbo moderately

[1] Salter, Trans. Geol. Soc., ser. II, vol. vii (1856), p. 221, pl. xxv, fig. 14; Lake, Ann. S. African Museum, vol. iv, pt. 4, No. 9, 1904, p. 213, pl. xxv, figs. 8, 9.

[2] Reed, Geol. Mag., Dec. IV, Vol. V (1898), pp. 502–505.

[3] Salter & Blanford, "Palæontology of Niti" (Calcutta, 1865), pp. 7, 8, pl. i, figs. 19, 20 (?).

high, incurved, rising well over that of opposite valve, with small triangular delthyrium below it. Hinge-line gently arched; cardinal extremities rounded; no distinct false cardinal area. Teeth large, stout, short; no dental lamellæ. Posterior and umbonal part of valve much thickened internally with deeply impressed trilobed muscle-scar, composed of short, broad, median, double groove in beak, bifurcating anteriorly into two elongated, narrow, pointed diductor scars diverging at 90°–120°, extending about one-third the length of the valve, dying out towards extremities, with a somewhat elevated crescentic area in the fork between them.

Brachial valve less convex than opposite valve, rarely with traces of weak median fold near anterior margin; umbo small, inconspicuous. Hinge-plate prominent, stout, divided medianly by narrow slit into two large subtriangular rounded lobes with vertical flattened faces, each bearing a submedian, small, sharp, crural process on a level with or slightly behind the dental sockets, and projecting obliquely forwards and downwards. Dental sockets deep. Median septum present, extending about half length of valve, thick at base, decreasing in height and thickness anteriorly. Muscle-scars weakly impressed, elongated, narrow, lying alongside of septum. Surface of valves marked by 150–200 narrow, low, rounded, closely-set, regular, simple ribs, of equal size, and not increasing by division or interpolation near margins; crossed by very fine concentric lines and a few rare growth-striæ.

Dimensions.—Average length 9–10 mm., width 11–12 mm.

Horizon and Locality.—Llandovery Beds, The Frolic, Haverfordwest.

Remarks.—The specimens occur in places in crowds, closely massed together, and are found as internal casts and external impressions of the shell. The external and internal characters of this Brachiopod much resemble the form described by Davidson[1] as *Rhynchonella* (?) *pentlandica* (Haswell), from the Ludlow of the Pentland Hills, and they are probably congeneric. The muscle-scars and teeth of the pedicle-valve and the medium septum and hinge-plate of the brachial valve seem modelled on the same plan, but the division of the hinge-plate and the presence of crural points are well marked in the Haverfordwest species, and the latter also lacks the longitudinal groove of the pedicle valve, and the ribs do not increase by interpolation near the margins. The shell also has normally a more transverse shape. The similarity of the muscle-scars in the pedicle valve to those in *Dayia navicula* (Sow.) is noteworthy. In external characters and ornamentation *Zygospira* (*Catazyga*) *Headi* (Billings)[2] may be compared, but the internal features more resemble typical members of the genus *Zygospira*, and to this genus it may be provisionally referred. It is distinguished from *Z. Hicksi*, Reed,[3] of the Slade Beds of Cuckoo Grove Lane, and Upper Slade, Haverfordwest, by its fine ribbing, and the different character of the muscular impressions in the pedicle-valve.

[1] Davidson, Mon. Brit. Brach., iii, p. 187, pl. xxii, figs. 9–18*a* (? figs. 19*a*, *b*).
[2] Hall & Clarke, Palæont N.Y., viii, Brach. ii, p. 157, pl. liv, figs. 24–34.
[3] Reed, Geol. Mag., Dec. V, Vol. II (1905), p. 452, Pl. XXIII, Figs. 17–19.

EXPLANATION OF PLATE XIV.

Fig. 1.—*Typhloniscus princeps*, sp. nov. Head-shield. × 2.[1] Sholeshook Limestone: Sholeshook railway cutting, Haverfordwest.
,, 2.—Ditto. Side view of same specimen, showing projection of anterior end of glabella. × 2.
,, 3.—Ditto. Portion of surface of cheek. × 4.
,, 4.—*Zygospira Haswelli*, sp. nov. Internal cast of shell, pedicle-valve. × 2½. Llandovery Beds: The Frolic, Haverfordwest.
,, 5.—Ditto. Another specimen. × 2½.
,, 5*a*.—Ditto. Brachial valve of same specimen. × 2½.
,, 6.—Ditto. Internal cast of shell, brachial valve. × 2½.
,, 7.—Ditto. Posterior view of internal cast of another specimen. × 2½.
,, 8.—Ditto. Impression of exterior, umbonal region, showing delthyrium in pedicle-valve. × 2½.
,, 9.—Ditto. Impression of surface of valve, showing ribbing and concentric striation. × 2½.

II.—On two new Gasteropods (*Hipponyx blackmorei* and *H. dibleyi*) from the White Chalk.

By C. Davies Sherborn, F.G.S., F.Z.S.

Some years ago Dr. H. P. Blackmore called my attention to some fragmentary remains of shell on Echinoids which he had found in the Salisbury district. These he regarded as belonging to *Hipponyx*. The true relationship of these fragments could not, however, be considered certain until Mr. Dibley found the almost perfect example seen in Fig. 1. Dr. Blackmore's finds are recorded in the list of fossils in the "Cretaceous Rocks of England" (Mem. Geol. Survey), iii, p. 473, as "Salisbury," but I have not discovered what form is there referred to under the localities of "East Kent" and "Margate."

Hipponyx blackmorei, n.sp.

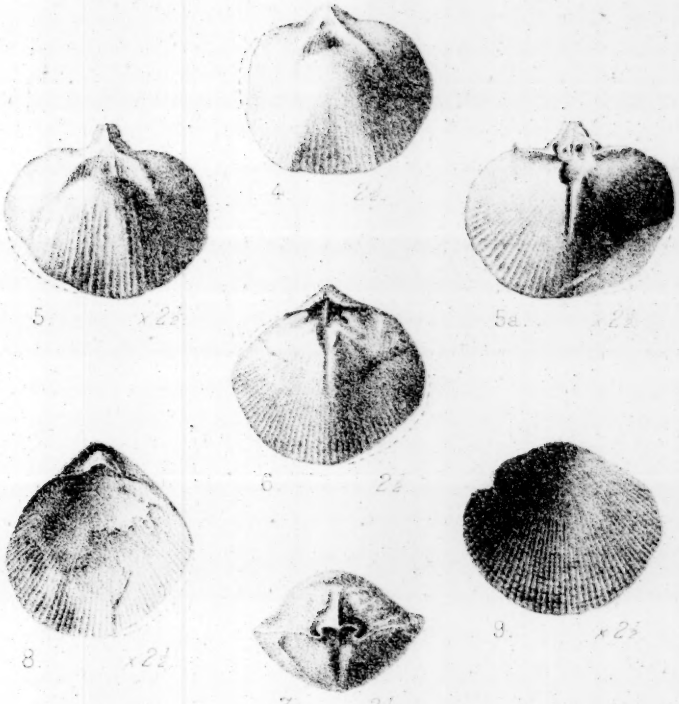
Shell thin, bearing numerous close but coarse radiating ribs, which are ornamented by swellings, becoming at the margin definite and like rows of beads. Apex unknown. Base thin, fairly regular, perfectly smooth, occupying three parts of the area.

Type.—Blackmore Collection, on an *Echinocorys* from the *Actinocamax quadratus* Chalk, East Harnham, near Salisbury. Partly overgrown by a *Spondylus*. Fig. 2, × 2. Another specimen, Blackmore Collection, on a *Micraster* from the *Micraster cor-anguinum* Chalk from Quidhampton. This specimen is in much the same condition as the last, but shows a little more margin of shell. As it does not show any base, it may not be in its original position.

Hipponyx dibleyi, n.sp.

Shell thin, with numerous close, radiating, fine ribs ornamented by irregular swellings, which persist to the margin of the test and do not appear to become bead-like. A few concentric lines of growth. Apex

[1] Marked in error on plate as magnified 1½ times.



4. 2½.

5. ×2½

5a. ×2½

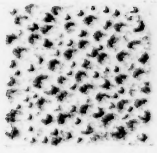
6. 2½

8. ×2½

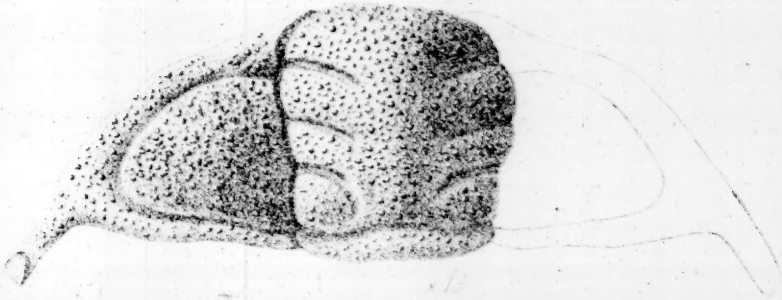
7. 2½

9. ×2½

2. ×2.



3. ×4.



×12.

A. H. Searle del. et lith. Vest, Newman imp.

Typhloniscus and Zygospira.

and base unknown. Irregularly covered with tubercles, the growing margin of the shell having taken up the natural markings of the Echinoid to which it had attached itself.

Type.—G. E. Dibley Collection, on a large *Micraster cor-bovis* from the *Terebratulina* zone of Cuxton, Kent. This specimen has two delicate tubes running across it, probably foraminiferal. Fig. 1, × 2 and Fig. 3, × 4, the latter showing the ornament. Apparently another specimen of this form is in Dr. Blackmore's collection, and comes from the *mucronata* Chalk of Clarendon, near Salisbury, but it is too crushed to allow of any definite description by me.

There is also evidence of a third species in which the ornament on the ribs is imbricate, but the fragment (in Dr. Blackmore's collection, from the *mucronata* Chalk of Alderbury) is not sufficient for descriptive purposes.

Dr. Blackmore's specimens are all too delicate to take casts from, but Mr. Dibley's specimen (*H. dibleyi*) is so well supported by chalk inside, and so firmly attached to the shell that Mr. F. O. Barlow, the skilful formatore of the British Museum (Nat. Hist.), has been able to take an exact cast for the National Collection by means of wax squeezes.

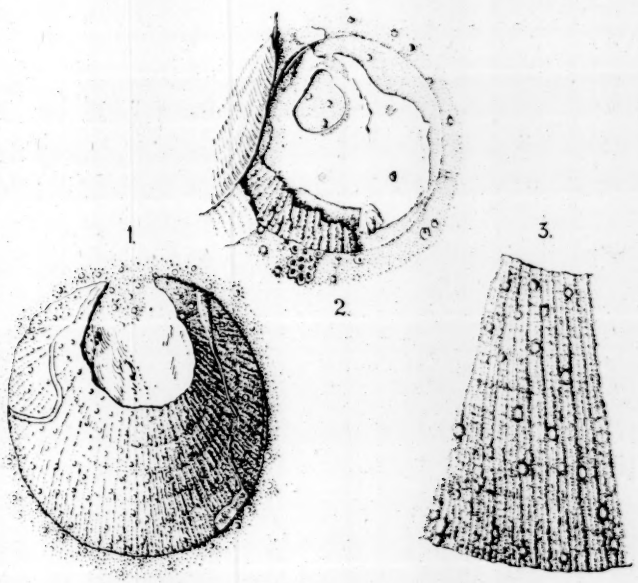


Fig. 1.—*Hipponyx dibleyi*, n.sp.; × 2; from the *Terebratulina* zone of Cuxton, Kent.

,, 2.—*Hipponyx blackmorei*, n.sp.; × 2; from the *Actinocamax quadratus* zone of East Harnham, Salisbury.

,, 3.—Part of Fig. 1 (*H. dibleyi*); × 4.

III.—On the Occurrence of *Haliserites* in the Upper Silurian and Upper Devonian Rocks of Victoria, Australia.

By Fredk. Chapman, A.L.S., F.R.M.S., Palæontologist to the National Museum, Melbourne.

(PLATE XXII.)

Preliminary Observations.

During the last few years there have passed through my hands for determination many specimens of a twig-like fossil-plant from the highest Silurian flaggy-sandstones of Victoria. These were usually too fragmentary to afford any very decided evidence as to their affinity, although their surfaces showed a close-textured and well-defined structure, referable to that of prosenchymatous wood-cells, and the stem had a definite central vascular axis, such as was first noticed by Hugh Miller in similar fossil remains from the Old Red Sandstone of Scotland.

Quite recently, however, the collectors of the Victorian Geological Survey have secured some better examples, chiefly from the Matlock district in Gippsland, which show not only the stem-like fragments well preserved, but also occasional imbrications or spiny bract-like leaves attached to the stems, together with short ovate (?) leaves and sporangia, and inrolled terminations to the branches. A good comparative series of *Haliserites Dechenianus*, Göppert, from the Devonian of Lethen, Nairnshire, Scotland, as well as from Wassenach, Laacher See, in the National Museum collection, afforded ample evidence as to the common identity of these and the Silurian fossils from Gippsland.

Remarks on the Genus.

Carruthers has already shown[1] that the genera *Haliserites*, Sternberg, and *Psilophyton*, Dawson,[2] are identical; but he has retained the latter generic name for the plant, notwithstanding that Göppert's species, *H. Dechenianus*,[3] was fully established by descriptions and drawings in 1852 as a form of *Haliserites*, whilst Dawson's description of *Psilophyton robustius* did not appear until 1859.[4] Kidston, whose synonymy of the species above quoted should be consulted, follows Carruthers in selecting *Psilophyton* in the place of the earlier described genus.[5]

In all probability the generic term *Haliserites* was discarded by the above-mentioned authors on account of the more perfect preservation of Dawson's specimens, which consequently lent themselves to the framing of a better diagnosis of the genus than was possible with Göppert's specimens; but the fact that the two genera were shown to be identical renders it clear that the earlier name, in accordance with the rule of priority, should be retained for this plant-form.

[1] Journ. Bot., n.s., vol. ii (Nov. 1873), No. 131, pp. 321–7, pl. 137.
[2] Quart. Journ. Geol. Soc., vol. xv (1859), p. 478.
[3] "Foss. Flora d. Ubergangs," 1852, p. 88, pl. ii.
[4] Quart. Journ. Geol. Soc., vol. xv, p. 481, figs. 2*a*, *b*.
[5] "Cat. Palæozoic Plants, Brit. Mus.," 1886, p. 232.

Possibly the misleading sound of the term *Haliserites*, named from its original comparison with the seaweed *Haliseris*, had some influence in determining the adoption of the later generic name. Nevertheless, in scientific nomenclature names are but names, and should never be regarded as accurate indices to the relationship of the organisms thus designated.

In a fully descriptive paper published in 1894 by Professor Penhallow,[1] who, by the way, does not notice Carruthers' previous work, both *Haliserites* and *Psilophyton* are retained, and a third genus, *Dictyotites*, is proposed. It seems evident, however, that the characters there used in attempting to establish these genera may be found in one and the same plant, according to its growth and preservation. For instance, the dichotomous terminations of *Dictyotites*, the apparently membranous fronds of that genus and *Haliserites*, and the spirally arranged scaly leaves, together with the circinate terminations of the branches in *Psilophyton*, may all be found associated, so as to suggest their common reference to a single plant-genus.

Occurrence in Victoria.

The Victorian Silurian specimens occur in a series of fine-grained brown and grey sandstones and indurated shales, which lies above the Yeringian strata comprising the fossiliferous conglomerates and limestones, and attains a thickness, according to the geological surveyors, of 10,000 feet in the Walhalla area. There is another series, known as the "*Monograptus dubius* beds,"[2] said to be below the Yeringian coral limestones, which also contains the remains of *Haliserites*, and this is of undoubted Silurian age. On the other hand, the extensive beds of sandstones containing *Haliserites*, first referred to, may represent a great development of a passage series linking the Silurian with the Lower Devonian in this area of Eastern Victoria.

Certain of our specimens from the newest Silurian rocks are in every way comparable with the well-known examples from the Caithness flagstones, figured by Hugh Miller;[3] and the spinose and spirally arranged leaflets and circinate terminals of the branches help to confirm Miller's and Carruthers' conclusions as to their Lycopod affinities. With regard to this relationship, Carruthers says (op. cit., p. 324): "From the various drawings and descriptions published by Miller, one can see that this plant had stigmarioid roots, a slender Lycopod-like stem, with the lower branches short, simple, or compound, and with numerous short acuminate leaves, and with the upper branches regularly dichotomising, with sharp edges produced by the absence of distinct leaves, the ultimate divisions being short and slender, and sometimes rolled up in a circinate manner at the tips. He also noticed the slender vascular axis running along the centre of the upper branches."

[1] "Notes on Erian (Devonian) Plants from New York and Pennsylvania": Proc. U.S. Nat. Mus., vol. xvi (1893), pp. 105–14, pls. ix–xiv.

[2] This graptolite, determined for the Survey by Dr. T. S. Hall, M.A., is typical of the Wenlock in England, but also ranges upwards into the Ludlows.

[3] "Testimony of the Rocks," 1857, pp. 428, 429, figs. 118, 119. Also Carruthers in Journ. of Botany, vol. ii (1873), pl. 137; especially fig. 4, specimen from the Isle of Stroma, off Caithness.

The genus *Haliserites* is also represented in our Victorian Upper Devonian micaceous shaly rocks, where it is associated with *Sphenopteris* (*Eremopteris*) *iguanensis*, McCoy, *Archæopteris Howitti*, McCoy, and *Cordaites australis*, McCoy. The examples there met with are, however, too fragmentary to admit of a closer determination than that of the genus.

EXPLANATION OF PLATE XXII.

Fig. 1.—*Haliserites Dechenianus*, Göppert. A specimen showing ovate (?) leaves. Near north boundary, Thomson River. × 2.

,, 2.—*H. Dechenianus*. Portion of a circinate termination. Same locality. × 2.

,, 3.—*H. Dechenianus*. Part of a stem with (?) sporangiophore and leaves. Centennial Mine. × 2.

,, 4.—*H. Dechenianus*. Cast of the mould of a stem, showing the outer woody layer of cells and conspicuous vascular axis. West of Thomson River. × 3.

,, 5.—*H. Dechenianus*. End view of a stem-fragment, showing vascular axis and flattened character of the once cylindrical stem. Centennial Mine. × 4.

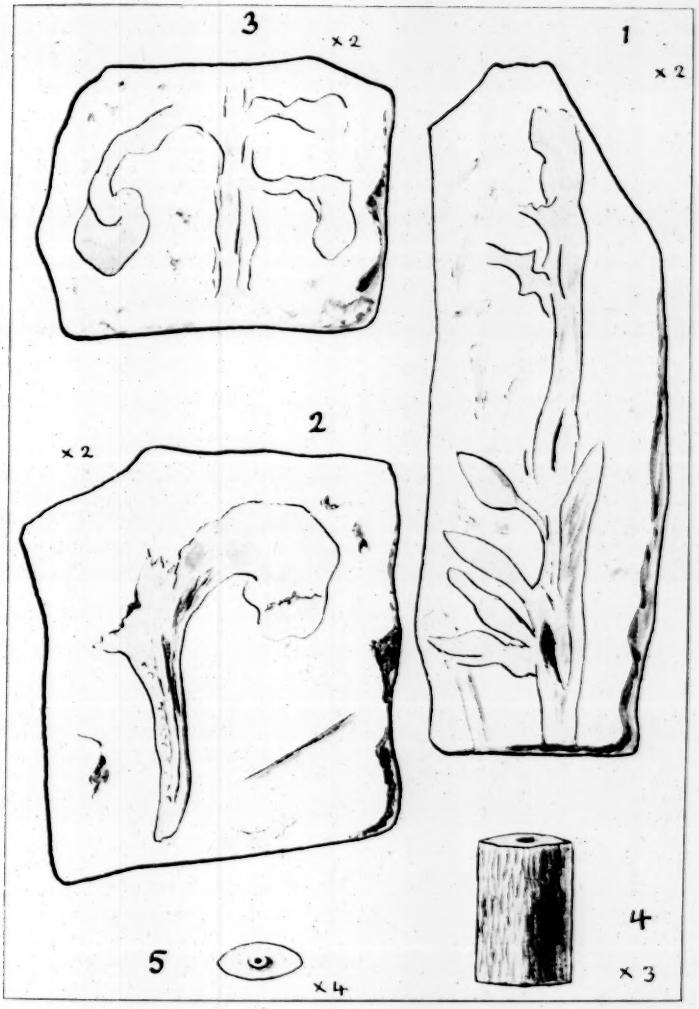
IV.—Note on the Discovery of a Bone of a Monkey in the Norfolk 'Forest-Bed.'

By Martin A. C. Hinton.

(Plate XXIII, Figs. 1–3.)

THE Upper Freshwater division of the Norfolk Forest-Bed Series at West Runton contains two distinct horizons, viz., a lower, consisting of a rather thick deposit of clay and peat, and an upper, containing a thin seam of gravelly sand, crowded with land and freshwater shells, on which reposes the pebble-bed found at the base of the '*Leda-myalis*' series. My friend Mr. G. White and I have lately collected extensively from the West Runton deposits, and have been rewarded with the discovery of several hitherto unknown voles, etc., which I hope to describe ere long. On comparing the voles from the lower series with those from the upper part of the Upper Freshwater bed one finds considerable differences between them, and I believe that similar differences are shown by the mollusca from the two horizons. These faunistic differences are of course not so great as those which have been shown by Dr. Forsyth Major to exist between the East Runton deposit and the West Runton series taken as a whole, but still they are similar in kind.

Mr. White has been so fortunate as to obtain, from the thin bed of gravelly sand at West Runton above mentioned, a most interesting bone, which he has kindly permitted me to study and describe in this note. The specimen is the distal end of a left humerus, and in the drawings which I have made (Pl. XXIII, Figs. 1–3) it is represented as seen in three positions. Viewed from the front (Fig. 1) the trochlea is prominent, and the capitulum for the radius is rather boldly convex. Between the two is seen a little rounded ridge, which, passing backwards and obliquely outwards round the articulation (Fig. 2), dies out before reaching the posterior surface (Fig. 3). This little ridge appears to be very characteristic of the humerus in Primates, and its function is to play externally into a groove on the inner side of the head of the



E. C. del.

Haliserites Dechenianus, Goppert, from the Silurian of Gippsland, Victoria, Australia.

radius, and internally against a longitudinal ridge developed towards the outer side of the sigmoid articulation of the ulna. Although very little remains of the shaft, there is sufficient to show that the fossil bone belonged to an at least nearly adult animal, all traces of the epiphysial suture being obliterated, and also to determine what is more important, viz. that there is no supratrochlear foramen. The epitrochlear process is mutilated, but enough remains to show that it, as well as the epicondylar process, are comparatively slightly developed for a monkey; and these features, together with the rather great convexity of the capitulum—suggestive of a slight degree of flexion of the fore-limb—indicate a species little given to climbing. The groove for the ulnar nerve is very clearly defined (Figs. 2 and 3), and the articulation is rather stout from before backwards (Fig. 2).

A careful comparison with the humeri of recent monkeys preserved in the British Museum and in the College of Surgeons shows that in all the characters above mentioned the fossil agrees with the larger members of the genus *Macacus*, and that it disagrees in one or other feature with every other genus.

The appended table of measurements will afford an idea of the relations subsisting between the fossil and the recent humeri as regards size. In comparing the humeri of the recent species of *Macacus* with each other, one sees great variations in the form of the articulation and of the epitrochlear and epicondylar processes, no two species, judging from the limited material before me, having these parts precisely alike. The comparison further shows that the fossil humerus has characters of its own, which will be best appreciated from the figures. It will suffice to state here that, judging from the variations seen in the recent species of *Macacus*, our fossil is by no means an extreme form, that it makes a nearer approach to *M. inuus* in some respects and to *M. rhesus* in others perhaps than it does to any of the other species, and that it differs from them far less than, for example, *M. sinicus* does.

Measurements of the Humerus in various species of *Macacus*.	Fossil, West Runton.	*M. inuus*, B.M. 324d.	*M. nemestrinus*, B.M. 29r.	*M. speciosus*, B.M. 1083b.	*M. rhesus*, B.M. 30g.	*M. cyclopis* ♂, B.M. 1486a.	*M. cyclopis* ♀, B.M. 1486b.	*M. brunneus*, B.M. 73. 9. 32.	*M. cynomolgus*, B.M. 29y.	*M. pileatus*, B.M. 1103g	*M. fascatus*, B.M. 1083a.	*M. assamensis*, B.M. 532a.	*M. sinicus*, B.M. 962a.
1. Transverse width of articulation.	19·5	24·5	22·5	22·5	18·8	18·2	17·5	20·3	16·4	21·3	19·0	18·0	18·4
2. Least antero-posterior diameter of articulation.	10·0	12·5	11·2	11·2	9·8	9·5	8·2	10·2	9·0	9·6	9·0	8·7	8·3

Pomel has described under the name of *Macacus travensis*[1] (and later as *M. proinuus*[2]) a species known from the limb skeleton alone, obtained from a Pleistocene phosphoritic breccia at Traras, near Aïn

[1] Pomel: Comptes Rendus, cxv, p. 157.
[2] Pomel: Carte Géol. Algérie, Monog. Pal., 1897, pl. iii.

Mefta, in Algeria. From the figures and description it is clear that *M. trarensis* had larger and stouter limbs than either *M. inuus* or the species represented by the West Runton fossil. With regard to the form of the distal articulation of the humerus, the West Runton fossil agrees more closely with *M. inuus* than with *M. trarensis*. Pomel states[1] that in young humeri of *M. trarensis* there is a supratrochlear foramen which is obliterated as age advances, and his observations lead him to believe that such a foramen is normally present in the young humeri of *Macacus*. I have failed to notice any trace of it in the humeri examined by me.

Dolichopithecus, an ape from the Astian or Middle Pliocene beds of Rousillon and Perpignan, had limbs very much like those of *Macacus* in structure, and the humeri figured by Depéret[2] are similar in form to the fossil before me. All the known species of *Dolichopithecus* are considerably larger than that to which the West Runton bone belongs, and while on the one hand *Dolichopithecus* belongs to the Middle Pliocene, *Macacus* on the other undoubtedly occurs in various continental deposits corresponding in age to our Forest-Bed series. I therefore prefer to regard this English monkey as referable to the genus *Macacus*, although it is possible that it belongs to a late and small species of *Dolichopithecus*. I do not doubt that the fossil indicates a species distinct from any of those recent forms with which I have compared it and from *M. trarensis*, but whether or no it be referable to any of the other fossil forms previously described must remain an open question, since there is no material known at present with which it can be compared.

Previous Records of Fossil Remains of Monkeys in Britain.

In 1839 Owen[3] referred a fragment of a lower jaw with the last molar and a detached molar, which had been obtained from the Eocene of Kyson in Suffolk, to a monkey, and in the "British Fossil Mammals"[4] he gave the name of *Macacus eocænus* to these remains. Later on Owen[5] founded a new genus of monkey for their reception—*Eopithecus*—and at a still later date, with further evidence at his disposal, he stated his belief that the fossils in question were really the previously unknown lower teeth of *Hyracotherium*,[6] a view which Kowalevsky[7] subsequently confirmed.

In 1845 Owen[8] described under the name of *Macacus pliocenus* a fragment of a right maxilla with the penultimate molar in place, which had been found by Ball in the brickearth series at Grays Thurrock in Essex, and a little later Owen published[9] a figure of the

[1] Pomel: Comptes Rendus, cxv, p. 158.
[2] Depéret: Mém. Soc. Géol. France, Pal. Mém. No. 3, p. 15, pl. i, fig. 4, and p. 125, pl. xii, fig. 6.
[3] Owen: Magazine of Natural History, September, 1839, p. 446.
[4] Owen: "British Fossil Mammals," 1846, p. 3.
[5] Owen: Palæontology, 1860, p. 341.
[6] Owen: Ann. Mag. Nat. Hist., 1862, ser. III, vol. x, p. 240.
[7] Kowalevsky, "*Anthracotherium*," pt. i: Palæontographica, Bd. xxii, p. 211.
[8] Owen: Comptes Rendus, xxi, p. 573.
[9] Owen: "British Fossil Mammals," 1846, p. xlvi.

specimen. Lydekker,[1] referring to this specimen, stated that it undoubtedly does belong to a monkey, but that the tooth is so worn that it is not possible to determine the genus. However, in a later work Lydekker[2] refers to it as "a species of *Macacus* from the Pleistocene brickearths of Essex," and in another place Flower & Lydekker[3] allude to it as a species of *Macacus*, very interesting as showing the existence of an ape at this late period in Western Europe. Beyrich[4] thought the reference to *Macacus* arbitrary, but Forsyth Major[5] was inclined to accept Owen's determination, saying: "Cependant cette dent possédant la forme générale et le mode d'usure qui caractérisent le *Macacus* et le distinguent du *Semnopithecus*," etc.

Certain doubts have been expressed to me as to whether the specimen in question, which is now in the British Museum, really came from the Grays brickearth, and I notice that neither in the Introduction to the Pleistocene Mammalia[6] nor in the lists given elsewhere[7] does Boyd Dawkins refer to the Grays monkey.

The reasons for this scepticism appear to be twofold, and with regard to each I should like to make a few remarks. The first and most general ground of suspicion is that, although the deposit at Grays was searched for fossil bones for many years, the fragment of jaw found in 1845 remains the unique specimen from that locality referable to an ape. But there are other animals known from the Grays brickearth whose remains are almost as rare, viz. *Felis catus*, the Hyæna and the Pig, and with regard to the remains of many small vertebrates which are now known to have occurred in extreme abundance in this deposit, it was not until 1899 that their existence in the Grays brickearth was suspected.[8] And even were there no likelihood of the remains of so small an animal as a monkey being overlooked, there would still remain the fact that the habits of the monkey are all against the chance of his remains being entombed in an ordinary fluviatile deposit.[9] It is a noteworthy fact that almost without exception such fossil remains of monkeys as we do meet with in fluviatile deposits are referable to *Macacus*, the least agile genus of the whole order.

The second reason appears to be that *Macacus* looks out of place in occurring at Grays, the Grays brickearth belonging to the Middle Terrace of the Thames Valley, and the deposits of this horizon yielding remains of such animals as *Ovibos* and *Dicrostonyx*. The

[1] Lydekker: Cat. Foss. Mamm. Brit. Mus., 1885, pt. i, p. 4.
[2] Lydekker: "A Geographical History of Mammals," 1896, p. 180.
[3] Flower & Lydekker: "Mammals Living and Extinct," 1891, p. 723.
[4] Beyrich: Abhand. d. Akad. d. Wiss. z. Berlin aus d. Jahre 1860, p. 23, 1861.
[5] Forsyth Major: Atti del Soc. Ital., 1872, xv, p. 86.
[6] Dawkins & Santord: Monographs of the Palæontographical Society, 1872, pp. xix and l.
[7] Dawkins: Quart. Journ. Geol. Soc., vol. xxiii, p. 101; ibid., vol. xxv, p. 199; ibid., vol. xxxvi, p. 398.
[8] Hinton & Kennard: Essex Naturalist, vol. xi, pp. 347–53.
[9] Falconer & Cautley: Trans. Geol. Soc. of London, 1837, vol. v, p. 499, and reprinted in "Palæontological Memoirs," 1868, vol. i, p. 292. The opening paragraph of this classical paper puts this view in the most striking manner possible.

Middle Terrace stage in the Thames Valley doubtless represents a very long period of time, and although stratigraphically the brickearths of Grays, Ilford, and Crayford and Erith are inseparable, the palæontological evidence is strong to the effect that they were not deposited at one time. I regard the Grays deposit as intermediate in actual age between the High Terrace drift of Greenhithe and the brickearth of Ilford, and I further regard the Crayford and Erith deposits as later than those of either Essex locality. This is not the place to discuss this question at any length, but, briefly, my reason for such views is that the Grays deposit yields only the older southern fauna, and it has consequently more palæontological affinity with the High Terrace[1] than it has with its stratigraphical equivalent at Crayford and Erith. On these grounds, and on the fact that the actual mineral condition of the fragmentary jaw agrees with the other fossil bones from Grays, I am disposed to regard the only known specimen of *Macacus pliocænus* as a genuine Grays fossil.

As Lartet[2] has stated, monkeys are intolerant of cold, and the occurrence of their remains in a deposit is a proof that at the time of their existence the climate of the region in which they lived must have been a genial one. Remains of *Macacus* are known from the Pliocene beds of the Val d'Arno[3] (two species), Montpellier,[4] and the Sewalik Hills,[5] and from the Pleistocene of Algeria,[6] from the Cave of Montsaumés (Haute-Garonne)[7] and the Heppenloch Cave in Wurtemberg.[8] The latter cave deposit was regarded by Hedinger and Nehring as of Pliocene age. Although at the present time *M. inuus* inhabits Gibraltar, it is a curious fact that no trace of its former existence there was found among the numerous fossil mammalian remains obtained from the Pleistocene cave deposits of the rock.[9]

In conclusion, I have to express my best thanks to Mr. G. White for the loan of the specimen; to Mr. E. T. Newton, F.R.S., Dr. C. W. Andrews, F.R.S., Dr. C. I. Forsyth Major, F.R.S., Mr. Oldfield Thomas, F.R.S., and Professor Keith for much kind help.

[1] Hinton: Proc. Geol. Assoc., vol. xv, p. 52. This question is more fully discussed in my account of the High Terrace Mammalia, which I hope will shortly appear, and in an account of the British Fossil Voles and Lemmings which I am preparing.

[2] Lartet: Ann. d. Sci. Nat., serie v, tome viii.

[3] Cocchi, "Su di due scimie fossili italiane," 1872; and Forsyth Major, Atti del Soc. Ital., xv, p. 89; Ristori, Boll. Comit. Geol., 1890.

[4] Gervais: Zool. et Pal. Français, 1859, p. 11, figs. 4, 5, *M. priscus*.

[5] Lydekker: Rec. Geol. Surv. India, xi, p. 66, and xii, p. 41, pl. i, *M. sivalensis*.

[6] Pomel: Comptes Rendus, vol. cxv, p. 157, and Carte Géol. Algérie, Mon. Pal., 1897, pl. iii.

[7] Harlè: Mém. Soc. d'histoire nat. de Toulouse, 1892, p. 2, and Cat. Palæont. Quatern., 1899, p. 27. I have not seen the latter work.

[8] Hedinger: Neues Jahrbuch f. Min., 1891, Bd. i, p. 169, Taf. 10.

[9] Busk: Trans. Zool. Soc., vol. x, p. 129. Trouessart (Cat. Mamm., vol. i, p. 26) mentions *Macacus fossilis*, Gibraltar, a record based on the following reference by Calderon (Q.J.G.S., vol. xxxiii, p. 128): "Quadrumana: Peñon of Gibraltar? *Imrie*," but I believe Busk's statement to be accurate.

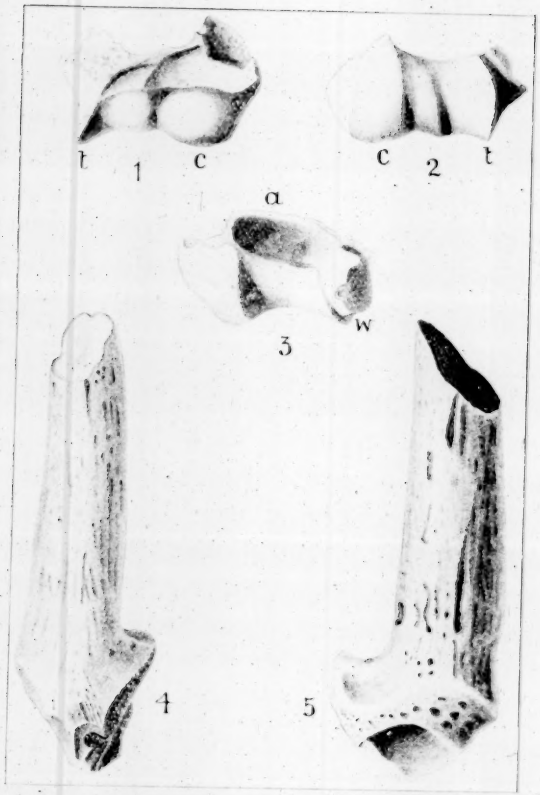


Fig. 1.—Distal end of left humerus, *Macacus* sp., from the "Upper Freshwater Bed" of West Runton. *t* = trochlea, *c* = capitulum; seen from the front.
" 2.—The same, seen from below.
" 3.—The same, hinder surface. *ie* = groove for ulnar nerve, *a* = anconeal pit.
" 4.—Right frontal and horn-core of *Gazella Bavisii*, Hinton; Norwich Crag, Brancton. Anterior view.
" 5.—The same, seen from the outer side.

All the figures are drawn of the natural size.)

V.—Note on *Gazella Daviesii*, Hinton, an Antelope from the Norwich Crag.

By Martin A. C. Hinton.

(Plate XXIII, Figs. 4, 5.)

In 1906 I described[1] a horn-core of a small antelope which had been obtained long ago from the Norwich Crag of Bramerton, and which is now in the collection of Mr. A. S. Kennard. This specimen formerly formed part of the Bayfield collection, and Mr. William Davies had determined it as a horn-core of *Capra* or Antelope. A comparison showed that it was referable to the genus *Gazella*, but that it differed from *Gazella anglica*, a species from the Norwich Crag described by Mr. E. T. Newton,[2] as well as from all the other living and fossil Gazelles respecting which I could obtain information. I therefore ventured to found a new species, *G. Daviesii*, for the reception of Mr. Kennard's specimen.

Unfortunately it was not in my power to give a figure of this horn-core, and the bare description could be of little value. Thanks to the kindness of Dr. Henry Woodward, an opportunity has been given to remedy this defect, and in the accompanying Plate (Pl. XXIII, Figs. 4, 5) the specimen, a right frontal and horn-core, is shown from the front and from the outer side. Compared with *G. anglica*, the principal differences presented by the fossil here figured are the much smaller size, the relatively and absolutely longer pedicle, and the rounder and less compressed horn-core, which has a slight outward curvature instead of being perfectly straight. The pit behind the pedicle on the outer side, so far as it is preserved, appears to have been much shallower than in *G. anglica*.

In my earlier paper mention is made of a much rolled and damaged horn-core obtained by Mr. H. B. Woodward from the Norwich Crag of Thorpe and now in the Geological Survey collection, and I stated that[3] "it certainly is not referable to *G. anglica*, and in my opinion represents a species distinct from that which I have here named *G. Daviesii*." By some chance I had overlooked Mr. Newton's reference to this specimen.[4] He had already stated that it was distinct from *G. anglica*, and suggested that it might belong to some other genus of Antelope and not to *Gazella*.

VI.—On the Low-Water Channels in Rivers and Estuaries.

By T. S. Ellis.

A critic of my paper on "The Winding of Rivers"[5] writes to me that I and others "do not take into account the nature of the soil traversed by a stream," which "must materially affect its course." Let me call attention to the two figures (117 and 118) on p. 499,

[1] Hinton: Proc. Geol. Assoc., vol. xix, pp. 247–51.
[2] Newton: Quart. Journ. Geol. Soc., 1884, vol. xl, pp. 280–93, pl. xiv.
[3] Hinton: op. cit., p. 251.
[4] Newton: op. cit., p. 280.
[5] Geol. Mag., March, 1908, p. 108.

vol. i, of Sir A. Geikie's Text Book of Geology, ed. 1903.[1] The one is entitled "Meandering course of a Brook," and resembles that which is often seen in meadows. The other represents the "Winding of the Gorge of the Mozelle above Cochem." There is no essential difference between them. Without knowledge of the scale I could not say that either had been formed in alluvium and not in hard rock. Both are based on the same principle; each is an adaptation, evolved from a more extended network of streams, formed to meet the requirements of the area to be drained. Lateral streams, even though they do not now exist—the growth of turf or of timber may have rendered them unnecessary—have united with that line in the network best adapted both for the longitudinal and the lateral drainage. In detail this may differ; in principle it is always the same.

A great geographer, E. Reclus, wrote that "most streams, however winding their course may have been, straighten as they approach the sea and descend towards the shore by the shortest line possible, so as to form a right angle with the coast."[2] The difference is more apparent than real. Estuaries are regarded and shown on maps as they are seen at high water; rivers in their ordinary channels, not as they are at flood-time, when they extend to the sides of the valley, which may be as straight as the margin of the estuary. A river winding in a meadow really corresponds to a low-water channel winding between banks of sand and mud. The purpose of this paper is to show that the course of the low-water channel in the bed of a river, and that of the low-water channels in an estuary, are decided on the same principle.

I have found that a firm faith in the soundness of these views, extended from, but in principle the same as, those recorded more than a quarter of a century ago,[3] sometimes enables me to predict that conditions would, on enquiry, be found to exist although not represented on a map. In a discussion on a paper by the late Mr. Vernon-Harcourt, read before the Institution of Civil Engineers and entitled "The River Hooghly," he states, in his reply to written comments, that "Mr. Ellis had to assume the existence of tributaries which did not appear on the charts."[4] I had assumed this, and large-scale maps of the Hooghly district, afterwards consulted, have justified the assumption. An Admiralty chart, since published,[5] is partly shown in Figs. 1 and 2. On this I rely to support my case. I may remark that the draughtsmen were simply directed to copy the tributaries shown on the chart. The names of streams, when not given there, are indicated by letters; they have been obtained from the large-scale maps.

Fig. 1 commences just below the Botanical Gardens, opposite the docks at Kidderpur, about three miles below Calcutta. At first it shows the river taking a straight course in a narrow but well-defined channel, and, as may be noted, no side-stream enters. Then, opposite

[1] pp. 108, 109 in edition of 1882.
[2] "The Earth," p. 287.
[3] "On some features in the Formation of the Severn Valley"; Gloucester, 1882.
[4] Proc. Inst. Civil Engineers, vol. clx (1904–5), pt. 2, pp. 168, 202.
[5] John Smith, The Minories, London.

Hangman Point, the large Sursuthee Khall (*a*) enters on the convexity, and there is a well-defined channel on this side only. Lower down three Khalls (*b*, *c*, *d*) appear at the convexity on the opposite side, and there is a well-defined channel there. Then in the Koffri Reach, on the right side, three streams appear, not, however, named, and the channel is on this side. Then at the inlet of the Cherrial Khall (*e*) the channel is on the left side, and remains so until it passes round Achipur Point, where the drainage from a large area comes in at the convexity on the opposite side. Here the channel remains until it has received the Champee Khall; then, with tributaries on both sides, there is a 'bar' in mid-stream. Then the large Royapur Khall (*i*) comes in at a convexity on the opposite, left, side. There it remains until, with the Royapur Bar intervening, it is transferred to the right side, where the important Hog River is received.

Close to the left bank, opposite Hiraguni Point, an extension of the deep-water channel is seen pointing upwards. Such features are common in tidal rivers and estuaries; they are formed by the tide, unable to cut a passage *through*, before it has risen to such a height that it flows *over* the shoal, and a passage through it is unnecessary. As they are tongue-shaped and tell of the direction of the tide in its first onset, I call them *tongues of the early* tide. A similar feature less frequently seen is caused by the stream. There is one on the opposite, right, side, where the tongue points downwards. These may be called tongues of the low-water stream. A little lower on this side is seen a double tongue, manifestly due to the tide. Here I may add that these tongues generally extend a little beyond the entrance of a side-stream, as if the tide or stream found an easy course along a channel kept open by the side-stream, but could get only a little beyond it. This is seen on the map in each case. These features seem to indicate the great importance, in the management of a tidal river, of securing, as far as possible, harmony between the direction of the stream and that of the tide.

Fig. 2, continuing the river downwards, shows features corresponding to those above. The Hog River is, clearly, the influence which keeps open the main channel on the right side until the influence of a large stream (*k*), coming in on the left, brings it over to Fisherman's anchorage. The direction of the tide, directly up the channel, is well shown by a *tongue* in the shoal just below Brul Point; similar features are seen just below the mouth of the Damuda River. Here the channel is still on the left side, which the large Fulta Creek may explain; the Damuda River, which is said to have driven the stream over to the left, does not really seem to have current enough to keep quite clear any part of its own outlet. Now we come to the region of the James and Mary Shoal, which Sir F. Treves[1] mentions as "the most villanous of all shoals in this evil river." If a ship touches it she sinks in the soft mud and disappears. All the engineers seem to be agreed that a single, permanent channel should be on the right side. I ventured to express an opinion, without knowing the fact, that tributaries did come in on the left side and kept open

[1] "Inner Side of the Lantern."

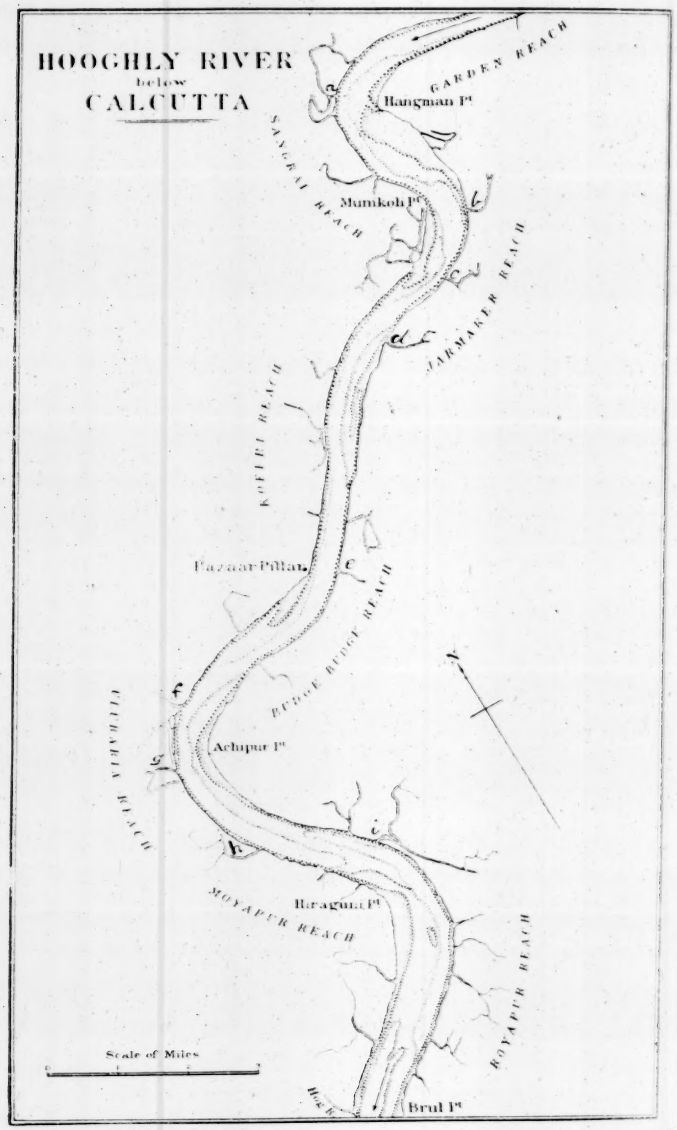


FIG. 1.

a. Sursuthee Khall.
b. Murmekhalle K.
c. Meerpur K.
d. Goom Khall.
e. Cherrial Khall.
f. Canal from Rajapur Jheel.
g. Bahirtuffa Khall.
h. Champee K.
i. Royapur K.

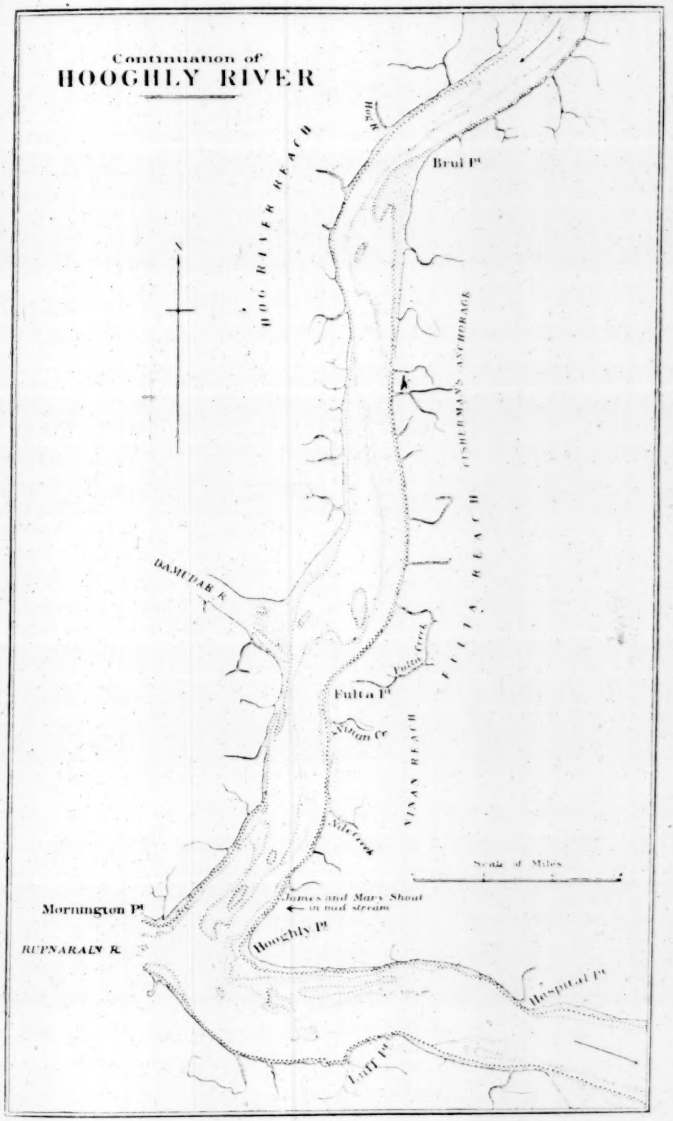


FIG. 2.
k. Chowgarra Khall.

the channel there. My reasoning was that the persistence of a shoal in the mid-stream of a river constantly depositing and removing mud indicated some need for a channel on both sides; and having regard to the line of the tide coming round Hooghly Point and going over to the other side, where, as shown by the tongues in the shoal, it is directed towards Ninan Creek; having regard also to the main stream which from Fulta Creek is directed downwards to the right side, tributary streams seemed to be necessary to account for the persistent channel on the left or eastern side of the shoal. Moreover, it appears that the eastern gut, as it is called, does in the dry season, that is, when there is no local water, partially close, when ships pass on the western side. Thus, in suggesting that the supposed tributaries should be intercepted and united in one channel brought out towards Hospital Point, I did but suggest the perpetuation of conditions under which this undesirable channel does tend to close. Every stream below Ninan Creek should, as I suggested, be so diverted, and the eastern gut be rendered unnecessary as a first step towards its extinction. Then, in my view, the stream would pass from Ninan Creek over to the right side, which is in the line of the tide as indicated by the tongues in the shoal, and a single, continuous channel would be assured.

Mr. Vernon-Harcourt's proposal is to put a long training-wall, extending from Fulta Point, into the shoal: he ignored the tributaries on the left side; he did not in his printed plan indicate their existence. Yet, being there, the creek between the proposed training-wall and the shore could not possibly close.

Fulta Point seems to illustrate a principle which I have long tried to impress on friends concerned in the management of estates. The margin of a river should be drained in a direction away from the stream, and the drainage be brought into the river only at fixed points as far apart as possible. Here the head of the stream is near the margin of the river, and a permanent promontory has formed. The formation of natural, raised banks, or levées as they are called on the Mississippi, seems to be promoted by a division of the flood-water as it recedes, part flowing into the river and part into the lateral drainage, thus leaving a line comparatively free from current.

Neither the map of a survey in 1851–5, to a scale of 1 inch to a mile, nor a later one to a scale of 4 inches, show the tributaries plainly. I am, however, satisfied that a complete map, taken with the chart, would show that every part of the river might be classed under one of these headings.

A. No stream coming in on either side—a straight, well-defined channel.

B. Streams coming in on one side only—a well-defined channel on that side only.

C. Streams coming in on both sides—an ill-defined channel and a disposition to form a shoal in mid-stream.

I may add that of twenty-five engineers who took part in discussing Mr. Vernon-Harcourt's paper, many of them writing at great length, not one seemed to recognize tributary streams as having any influence at all in diverting the river-channel towards their outlets.

Want of space forbids comment on many other points of interest in the paper and in the discussion upon it.

In a wide estuary, where the swing from side to side of a single channel is not possible, there will be appearances of a struggle between the disposition of the river-stream to go in a median line and the influence of tributary streams in keeping open channels on either side which the river-stream may, wholly or partially, adopt. Certainly, while these influences exist, the formation of a single, continuous channel is impossible. What would happen in the case of the Hooghly estuary if all streams coming in on the eastern side were diverted into the channel behind Saugor Island is an interesting speculation. My belief is that the channel on the western side to which the River Haldia gives its name would become the principal one.

Estuary conditions are well seen in the wide, crescent-shaped expansion of the Mersey above Liverpool. Here, in the low-water channels one can see the influence of the tide, of the main stream, and of the tributaries on either side. I can imagine all of these latter on the northern shore, east and west of Hale Cliff, diverted and brought in at Widnes and at Garston, so giving an unbroken front of more than 8 miles. Then, with no need for a channel there, the main stream would follow a great curve on the southern shore, adopting the channel kept open by the Weaver and other streams, which would accord with the line of the tide coming up to Eastham, directed there by the quay walls of Liverpool and of Birkenhead.

Fig. 3 shows the estuary of the Exe with the low-water channel on the left side at Topsham, 4 miles below Exeter. There is no apparent obstruction to prevent a straight course to the sea; the channel is, however, directed towards the right side, but not in a straight line; the upper part is inclined somewhat eastward towards a similar inclination, westward, of the channel continuous with the River Clyst. The two elbows, pointed towards each other, suggest a former union and a comparison with similar features to be seen in rivers and brooks, as mentioned in the previous paper.[1] The channel of the Exe crosses to the right side, where it receives streams coming in near the entrance to the canal. Being here, there is no apparent reason why the channel should not be continued on the same side and unite with Powderham Pool, lower down. It does go over towards the left side and unites with the channel of the Clyst. Again, with no apparent reason why the united channel should not go direct, it crosses over to the right side and receives the Kenn. Again, with a direct course freely open, it goes over and unites with the Lympstone Lake, which comes from the left side. Finally, the channel in its progress towards Exmouth again inclines to the right and receives several streams coming from this side. The influence of the tide in maintaining channels is overrated. Here, the bar thrown up by the current in the sea, running from west to east, would close the estuary if a channel were not kept open by the stream.

The course which the low-water channel in the estuary would take if it were decided by the direction of the tide is clearly indicated by

[1] Geol. Mag., March, 1908, p. 111.

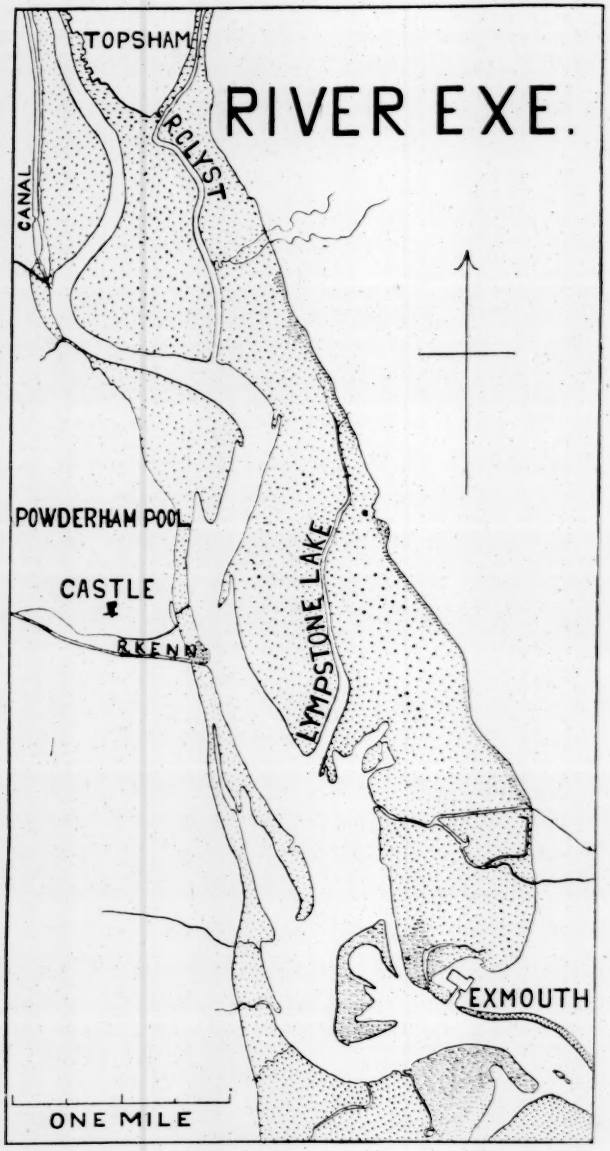

TOPSHAM
RIVER EXE.
R. CLYST
CANAL
POWDERHAM POOL
CASTLE
R. KENN
LYMPSTONE LAKE
EXMOUTH
ONE MILE

Fig. 3.

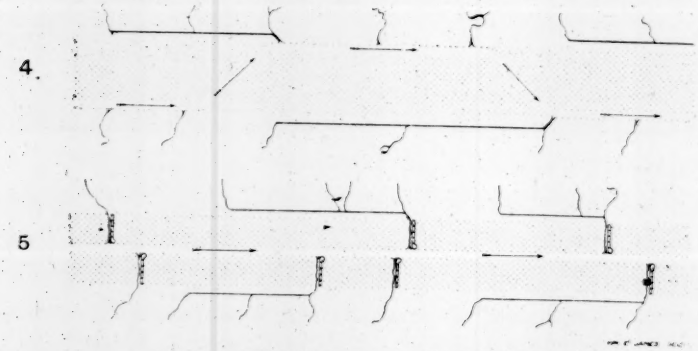
Powderham Pool, a *tongue of the early tide* and a permanent feature as indicated by the fact that it has a name. Twice a day the tide attempts to force a passage directly up the river, but succeeds only in removing the mud left at high-water by the previous tide. Not only is the tide unable to cut a way through the shoal; it has been powerless to prevent the formation of it. Permanent features in estuaries are much more interesting than changes; they serve to indicate conditions which conduce to stability. On examination of the map, one of these tongues is seen opposite the mouth of the Kenn, where the early tide has been deflected by a breakwater. Other tongues are seen farther up the low-water channel, the course of which, evidently, is decided by the stream.

While, in the Exe, the low-water channel passes, through mud, obliquely across the river from the mouth of one tributary to that of another, in the Severn we can see the same thing where the channel is cut in hard rock. The Wye, and a smaller stream just below, are on the right side of the Severn, and the channel is on this side; then it passes obliquely across to the mouth of the Avon, along The Shoots, a cutting in hard rock. We have evidence that it was really cut by material moved by water; when the foundations for the Portskewet Pier (for the ferry) were excavated, the holes were filled at each tide, "sand, gravel, and stones double the size of a man's fist being often found." The line of the early as of the higher tide would not be along this channel if free to take its own course. A *tongue of the early tide*, the Whorl's End, just above, a precisely similar feature to Powderham Pool, has its point directed up the line of the Severn, and is of the same shape as every map has shown it to be for the last hundred years. The tide has, of course, been an active agent in cutting The Shoots; the line of this channel was decided by the stream.

The tide may serve to keep open or to close a channel, to prevent or to cause the formation of new land, according to the presence or the absence of a stream. Throughout a long line from Crossens, on the Ribble, by Southport, no stream falls into the sea, and there is a great accretion of land until, at the mouth of the Alt, the line of the new land recedes. I have often thought that the Nene and all the smaller streams between the Ouse and the Welland might be diverted, right and left, into these rivers so as to give an unbroken front of eight miles. Then a very large area of new land would quickly form in the Wash between the two rivers as they extended their course towards the sea along the coast of Norfolk and of Lincolnshire.

To control the course of a river at high tide or at time of land-water flood may be difficult, but the low-water channel, which, after all, means the deep-water line, would, generally speaking, be easy. If tributary streams fall in on one side only of the river, the channel will be on this side only. A change may be made from one side to the other if, at the point of crossing, no tributary come in on either. So, too, in the case of either a river or an estuary of moderate width, a channel may be fixed in mid-stream if the tributaries, singly or united, be carried out by training-walls to fixed points on either side of the intended channel, not necessarily a straight one if it afford

a fairly good flowing line and be sufficiently in accord with the direction of the tide. I assume that the training-walls are up to the level of low water only, so that the tide or flood-stream can pass freely over them. Let either of these conditions, expressed in Figs. 4 and 5,[1] be fulfilled and the low-water channel will be permanent. If the contrary can be shown, I shall have to admit that I am wrong.



Diagrams of Rivers with Stable Channels.

Fig. 4.—Tributary streams coming in on one side only; none at the crossing of the channel.

,, 5.—Tributary streams directed by training-walls to fixed points on either side of the intended channel.

VII.—Nathorst's Methods of studying Cutinised Portions of Fossil Plants.

By F. A. Bather, D.Sc., M.A., F.G.S., etc.

Botanists who study the tissues of living plants, or those palæobotanists who deal with actual petrifactions, have scarcely any idea of the difficulties that meet the worker on carbonised plant-remains, especially when the material is so limited that the research cannot be repeated in the event of damage to a single preparation. Moreover, the research can be conducted only on those portions of the tissue that are cutinised, since all the rest have been carbonised or destroyed in the course of fossilisation, and no longer appear after the preparations have been bleached. The student of Mesozoic plants is in the further unhappy position that, with a few notable exceptions, he rarely finds portions of the plant that show any structure; he in particular must direct his attention to the cutinised membranes, and above all to the cuticle of the leaves and stems and, in the case of Pteridophyta, to the spores.

So long ago as 1856, J. G. Bornemann, in his memoir "Ueber organische Reste der Lettenkohle Thüringens," described some cuticles, which, thanks to the maceration of the leaves in the course of fossilisation, had been preserved in such a way that they

[1] For these two diagrams and for valuable assistance I am indebted to a young engineer, Mr. W. E. James.

could be studied under the microscope without more ado. "The whole process," he writes, "of obtaining these natural microscope-preparations of the epidermis of fossil plants consists in loosening them from the clay under water with a spatula, mechanically washing the adherent clay from the membrane, and then enclosing the latter in hot, fluid Canada balsam between two glass plates." As a rule, however, more elaborate methods are needed both to obtain the cuticle and to render it fit for study.

August Schenk, in his memoir on "Die fossile Flora der Grenzschichten des Keupers und Lias Frankens" (Wiesbaden, 1867), was probably the first to make any considerable series of such preparations, as well as of the spores of various ferns. Similar researches have been made by R. Zeiller, who, in his "Observations sur quelques cuticules fossiles" (1882, Ann. Sci. Nat., ser. VI, Botan., vol. xiii, pp. 217–38), explained certain methods of treating the cuticle chemically. The cuticle of most plants, though insoluble in cold concentrated sulphuric acid, is dissolved in hot nitric acid, being changed by oxidation into suberic acid; it is also saponified and dissolved by boiling in potash. Fossil cuticles resist concentrated sulphuric acid even when boiling, and are dissolved in nitric acid only by prolonged boiling, the residue giving the usual reaction for suberic acid; they are not acted on by potash. As first observed in the Papierkohle, the carbonaceous matter separating the membranes is not carbon but ulmic acid, and this is soluble in slightly warmed ammonia or potash. Truly carbonised matter may be attacked by chlorine water ('eau de chlore') or by nitric acid, which oxidises it into ulmic acid soluble in alkalis.

Methods based on the foregoing facts have been employed by Zeiller and subsequent authors in this country and elsewhere, but have recently been improved by Dr. Hjalmar Möller, working under the direction of Professor A. G. Nathorst. A full account of them, with examples of their use, is given in some valuable memoirs recently published by Professor Nathorst,[1] and the interest taken in his collodium-method[2] suggests that some abstract of his present remarks may also prove welcome.

In studying carbonised leaves, the usual method has been to bleach them with chlorate of potash and nitric acid[3]; now it is found preferable generally to use the aqueous solution of potassium hypochlorite known as Eau de Javelle. This, being slower and gentler in its action, enables one to obtain larger portions of the leaf-cuticle unharmed. Sometimes, it is true, the material is not appreciably attacked by the Eau de Javelle, and recourse must then be had to the older method.

[1] A. G. Nathorst, 1908, "Paläobotanische Mitteilungen, Nos. 3–6": K. Svenska Vet.-Akad. Handl., xliii, 3 and 6. No. 3, "*Lycostrobus Scotti*, eine grosse Sporophyllähre aus den rätischen Ablagerungen Schonens"; No. 4, "Ueber die Untersuchung kutinisierter fossiler Pflanzenteile"; No. 5, "Ueber *Nathorstia* Heer"; No. 6, "*Antholithus Zeilleri*, n.sp., mit noch erhaltenen Pollenkörnern aus den rhätischen Ablagerungen Schonens." In all, 46 pages, 6 plates.

[2] See GEOL. MAG., Oct., 1907, pp. 437–40.

[3] See, for instance, A. C. Seward, "Fossil Plants," 1898, p. 75, at bottom.

There is considerable difference in this respect between different classes of material, and it is not always easy to say beforehand whether the remains of a leaf will yield serviceable preparations of cuticle or not. Leaves with a well-developed cuticle, probably as a rule derived from xerophytes, are generally of a brownish colour, and so elastic that they can be more or less completely freed from the stone. Such leaves are frequently presented by the ginkgophytes and by some conifers, e.g. *Thinnfeldia*, *Ptilozamites*, and *Lepidopteris*. Leaves with a relatively thin cuticle may, however, in certain circumstances have been so preserved that they can be treated in a similar manner, e.g. *Dictyozamites*, *Otozamites*, and *Pterophyllum*. All such leaves yield good and fairly large preparations. On the other hand, leaves that are brittle and exceptionally carbonised fall to powder and yield no preparations of value. Between these extremes are all gradations, and even such leaves as resemble a homogeneous mass of coal may furnish good preparations if only large enough fragments of the leaf can be obtained. All these respond differently to the reagents. While leaves of *Dictyozamites* are completely bleached by Eau de Javelle in a few hours, others take as many days or weeks, or even a longer period, to become sufficiently transparent. The action of the reagents may, however, be hastened by warming.

When the leaf has become transparent it still consists of the cuticle of the two sides, and these have to be separated with dissecting needles. If a part of the leaf-margin is preserved, it is advisable to bend the cuticle of the under side round the margin so as to lay it flat alongside the cuticle of the upper side while retaining its connection therewith. Thus comparison of the two sides is facilitated. For mounting preparations of cuticle, glycerine-jelly is better adapted than Canada balsam.[1]

Although the use of the microscopic study of the cuticle has been generally recognised since the publication of Schenk's work, still it has scarcely been taken advantage of to the extent that is desirable. In every case the systematic determination of a leaf should be checked, when possible, by the study of its cuticle, since the outer form is so deceptive that one can rarely depend on it alone. A notable instance of this is furnished by the leaves from Greenland which were regarded as *Cycas* leaves by Heer and all other botanists, and served as basis for many conclusions of importance to climatology and plant-distribution. Eventually study of the cuticle enabled Professor Nathorst to prove that these leaves did not belong to *Cycas*, but to a new genus, which he named *Pseudocycas* from its remarkable resemblance to *Cycas* in outer form.[2] None the less, the examination of the cuticle should always be combined with as complete a study as possible of the leaf itself. To make and describe preparations of cuticle is easy enough, but is of small value unless one can give some account of the form and structure of the leaves to which they belong.

To turn to the Spores. Whereas those of the Palæozoic Lycopodiales

[1] A. G. Nathorst, 1907, "Paläobotanische Mitteilungen, No. 2, Die Kutikula der Blätter von *Dictyozamites Johnstrupi*, Nath.": op. cit., xlii, No. 5.

[2] A. G. Nathorst, 1907, "Paläobot. Mitt. No. 1, *Pseudocycas*, u.s.w.": ibid.

are fairly well known, especially the megaspores, this is not so with the spores of other fossil pteridophytes, except in the case of those species that occur as actual petrifactions. Spores in themselves are of no great interest, but when found in connection with the mother-plant they should always be studied, if only to complete our knowledge of the plant itself. Good results may often be obtained from unpromising material.

When the sporangia of Mesozoic or Cainozoic ferns are preserved in a carbonised state, they are freed from the matrix and treated with Eau de Javelle or with chlorate of potash and nitric acid. By these reagents the wall of the sporangium is quickly destroyed. To remove the ulmic acid produced by this treatment, it is advantageous, though not always necessary, to follow it by treatment with ammonia; this renders the spores more transparent. After the destruction of the sporangium-wall the spores often continue clinging together so that they can be studied in their original position. Examples of this are given in Professor Nathorst's communication No. 5, "Ueber *Nathorstia* Heer." If the treatment with ammonia is continued long enough, the spores usually become separated from one another; but the same result may be obtained by breaking up the group with a dissecting-needle or simply by pressing on the cover-glass. Such isolation of the spores is of course necessary for their further study.

After successful experiments with Triassic ferns, Professor Nathorst proceeded to apply his method to Palæozoic species. Two specimens were taken at random, one of *Pecopteris Miltoni*, the other labelled "*Cladophlebis Nestleriana* B[rongn.] fructif." Carbonised portions corresponding to the position of the sorus were freed from the matrix and treated with chlorate of potash and nitric acid. The small brownish-yellow fragments that remained were then subjected to the action of ammonia while on the microscope-slide, and the ulmic acid thus removed; this action was accelerated by warming. It was very interesting to follow under the microscope the gradual emergence of the spores from the apparently homogeneous mass, till at last they were completely exposed.

In many cases the spores long remain united, the simple reason being that they were not ripe when fossilised. Had they been so, the sporangia would have opened and scattered them, and it is of course in the unopened sporangia that spores are detected by these researches. It is, however, peculiar that these unripe spores should already have possessed so strongly cutinised a wall.

The success of Professor Nathorst's researches on specimens taken at random suggests that almost any fossil fern of which the fertile soriferous leaves are carbonised might yield preparations of spores. Just now, too, when it has been recognised that many supposed Palæozoic ferns really belong to the pteridosperms, the method might be of exceptional value, even though it be not always easy to distinguish an isospore from a microspore. The seeds of pteridosperms also are often small and liable to be confused with sori or synangia, but this method affords a ready means of distinguishing them. For example, the supposed seeds of *Carpolithus Nathorsti*, Arber, prove to be elongate collections of minute egg-shaped spores: whether fern-spores

or microspores cannot be decided, but at any rate the species is not a *Carpolithus*.

The structure of the sporangium itself can to some extent be made out by following the gradual action of the reagents under the lens or microscope. Besides the shape of the spore-sacs, one can see whether the sporangium tissue consists of one or many layers. An illustration of the method is provided by *Nathorstia*. Here the whole sorus forms a firm, closed capsule. When bleached with chlorate of potash and nitric acid, it has at first the appearance of a quite homogeneous, light-brown, discoid mass. When the action has proceeded further, strong illumination under the microscope enables one to detect the carbonised and still black septa between the groups of semi-transparent brownish spores. These septa coalesce in the centre and taper outwards, so that they form a star. On the addition of ammonia the sorus splits into wedge-shaped spore-groups. By pressing the cover-glass on these, the spores are loosened. All these stages are shown by microphotographs, of which the last represents most distinctly the tetrahedral form of the spores under a magnification of 260 diameters.

Not only ferns but other pteridophytes lend themselves to such researches on the spores. The spores of *Equisetites*, for instance, have just been discovered in this way by Mr. Th. G. Halle (Sv. Vet.-Akad. Handl., xliii, No. 1, 1908), and Professor Nathorst thus describes his own discovery of two kinds of spores in *Lepidostrobus Scotti* :—Here the sporangia are easily seen, and their thin wall is removed by Eau de Javelle, which thus exposes the megaspores. This first treatment further results in the recognition of their spore-nature, i.e. the unicellular nature of the dark-brown objects can be determined, while in some specimens one can also observe three ridges meeting at an angle of 120°, as well as a peculiar appendage. One specimen showed that this appendage was placed close upon the ridges, but this was seen more clearly in another preparation which, after the first bleaching with Eau de Javelle, was treated with alcohol and then bleached further. These preparations are remarkably transparent and allow the structure of the megaspores to be observed very exactly. Once clear as to this structure, the next step was to find the microspores, should such be present. The quest did not seem likely to succeed, for very little carbonised matter remained, and none of this was above the assemblage of megaspores. The only part suitable for examination was further down, on the left side of the upper part of the uncovered flower-axis, and seemed to correspond to three sporophyll fragments with sporangia. This part, therefore, was cautiously removed from the stone slab and treated with fuming nitric acid. Since this, however, seemed too violent in its action, the treatment was soon interrupted and Eau de Javelle substituted for the acid. At the end of the bleaching, three closely compressed elongate parts could be distinguished. One of them displayed a collection of megaspores; another resembled it; both therefore corresponded to two megasporangia. The third part, however, showed no megaspores, but a perfectly homogeneous mass, on which there appeared here and there circular spots of about 0·28 mm. diameter. Small isolated fragments of the light brownish-yellow ground-mass were translucent

at the margins, and were surrounded by microspores that had separated from them. On teasing the ground-mass with the dissecting-needle, microspores appeared in countless numbers: the ground-mass was entirely composed of them, and the addition of ammonia broke it up into these constituents. These microspores are so thin that they can scarcely be seen if preserved in glycerine-jelly or Canada balsam, especially when they have been rendered more transparent by ammonia. Fortunately they can be stained with erythrosin, and this renders their outline very sharp and clear, so that it has been possible to reproduce microphotographs up to an enlargement of 750 diameters.

The pollen-grains of fossil gymnosperms also may be obtained by this method, and Professor Nathorst has studied the pollen-sacs of a fossil hitherto supposed to represent the male flowers of *Baiera Muensteriana*, but now described by him as *Antholithus*[1] *Zeilleri*, n.sp. The two very small specimens, contained in a soft fissile shale of Rhætic age, were first treated with nitric acid alone, afterwards with the addition of chlorate of potash, and it was soon seen that other fragments were present. On isolating these their form appeared quite different from that of *Baiera*, a fact that could not possibly have been distinguished otherwise. An unopened pollen-sac was treated in the same way as the sporangia mentioned above, and showed itself to be quite full of pollen-grains of oval shape and from 36 to 48 μ in length.

The indestructibility of spores and pollen-grains rendered it probable that they could be washed out of Mesozoic clay deposits, in the same way as plant-remains are washed out of Quaternary clays and sands (see Nathorst, Bihang Sv. Vet.-Akad. Handl., xvii, Afd. iii, No. 5, 1892; and G. Andersson, Geol. Fören. i Stockholm Förhandl., xiv, 1892). An experiment was therefore made with a certain Lias clay, found at Hör in Scania, and full of plants preserved as they grew, among which may be specially mentioned *Clathropteris meniscioides*, *Dictyophyllum Nilssoni*, and *Marattia hörensis*. A piece of this clay was taken and washed after treatment with nitric acid. Though of only some four or five cubic centimetres, it yielded an enormous quantity of different plant-remains. Besides the larger fragments, about fifty preparations of the finest mud were obtained, all containing hundreds of spores or pollen-grains, and yet not half the mud was used up. Obviously the clay was crammed full of such remains, and among them the tiny spores of Marattiaceæ predominated. Other forms could be referred with much probability to *Dictyophyllum* and *Clathropteris*. The most interesting occurrence, perhaps, was that of winged pollen-grains closely resembling those of *Pinus* (sensu lato), a genus previously unknown in rocks older than the Upper Rhætic of Scania.

There seems no reason to doubt that fruitful results would accrue from the extension of this research to other plant-bearing clays, no matter what their age.

[1] The name *Antholithus*, originally used by Linné in Syst. Nat., ed. xii, as a designation for '*Phytolithus floris*,' is here adopted by Professor Nathorst as a general term for all fossil flowers. It implies that the systematic position of the species cannot yet be determined. Compare the use of the words *Radiolus*, *Entrochus*, and *Cystis* in Echinology.

NOTICES OF MEMOIRS.

I.—British Association for the Advancement of Science. List of Titles of Papers read in Section C, and in other Sections bearing upon Geology, September 3rd to 9th, 1908.

Presidential Address by Professor John Joly, M.A., D.Sc., F.R.S.

Professor G. A. J. Cole.—The Geology of the Dublin District. (Lantern.)

R. J. Ussher, H. J. Seymour, E. T. Newton, F.R.S., & Dr. Scharff.—On the Cave of Castlepook, near Doneraile.

Professor G. A. J. Cole.—On Probable Cretaceous Outliers off the Coast of Kerry.

R. Carruthers & H. G. Muff.—The Geology of the Leenane District, Co. Galway.

H. Bolton.—On a Section of the Lower Coal-measures at the Emerald Pit, Dungannon.

G. H. Kinahan.—On the Raised Beaches of the Liffey Valley.

Professor J. Joly, F.R.S.—On the Igneous Rocks of the Outer Blasket Islands.

Professor G. A. J. Cole.—The Laterite and Bauxite Zone of North-East Ireland.

Professor S. H. Reynolds & Mr. C. I. Gardiner.—The Igneous and associated Sedimentary Rocks of the Tourmakeady District, Co. Mayo.

Dr. W. F. Hume.—Notes on the Petrography of Egypt. (Lantern.)

Dr. A. Hutchinson.—Dolomites from Algeria.

Dr. A. Hutchinson.—On a new method of drawing Stereographic Projections of Crystals.

Dr. H. A. Bemrose.—Notes on the Microstructure of Derbyshire Limestone. (Lantern.)

Professor J. Joly, F.R.S.—On the occurrence of Native Iron in the Deccan Basalt.

W. G. Fearnsides.—The Tourmaline Rocks of Cwm Dwthwc.

H. Brodrick.—Notes on the Formation of Cave Pearls.

Professor W. Boyd Dawkins, F.R.S.—The Derivation of Sand and Clay from Granite.

Dr. T. T. Groom.—Report on Charnwood Rocks.

Professor W. M. Davis.—Glacial Erosion in North Wales.

Dr. J. Milne, F.R.S.—The Duration and Direction of Large Earthquakes.

Professor C. Lapworth, F.R.S.—Report on Excavations through critical Sections in Shropshire and North Wales.

Dr. Tempest Anderson.—Changes in Soufrière of St. Vincent. (Lantern.)

Professor W. H. Hobbs.—Recent Changes in Level within the Basin of the Laurentian Lakes.

Professor W. W. Watts, F.R.S.—Report of Geological Photographs Committee.

Dr. Dwerryhouse.—Reports on Erratic Blocks.

Professor J. W. Gregory, F.R.S.—Report of South African Correlation Committee.

Dr. F. H. Hatch.—Report on South African Topographical and Geological Terms.

W. G. Fearnsides.—Report on Place-names.

Discussion on Mountain Building. Opened by Professor Joly, followed by Sir A. Geikie, Professor Lapworth, Professor Sollas, Professor Cole, Dr. Teall, etc.

E. Greenly.—Report of Committee on Anglesey Rocks.

W. Whitaker, B.A. Lond., F.R.S.—On the finding of Silurian Beds in Kent.

Dr. Woolacott.—On a case of Thrust and Crush Brecciation in the Magnesian Limestone, Co. Durham.

Dr. G. W. Grabham.—Well-water Supply of the N.E. Sudan.

H. Bolton.—Contemporaneous Erosion in the Lower Series of Coal-measures of the Bristol Coalfield.

Professor S. H. Reynolds.—Report on Pre-Devonian Rocks of Mendips and Bristol area.

J. W. Stather.—Report on Kirmington Deposits.

Professor H. G. Seeley, F.R.S.—On a Fossil Reptile with a Trunk from the Upper Karroo of Cape Colony.

Professor H. G. Seeley, F.R.S.—On the distinctions between the dentition of the fossil Reptilia classed as Cynodontia and Gomphodontia.

H. Brodrick.—Reptilian Footprints from the Inferior Oolite of Whitby.

J. Lomas.—Report of Trias Committee. (Lantern.)

Dr. A. Vaughan.—Report on Carboniferous Succession.

R. Welch.—On Dopplerite from Sloggan Bog, Co. Antrim.

Titles of Papers read in other Sections bearing upon Geology:—

SECTION B.—CHEMISTRY.

Professor W. N. Hartley, F.R.S.—Lithium in Radio-active Minerals.

Discussion on Peat, in which Dr. Woltereck, Captain Sankey, Professors Ryan, Johnson, and Lyon, Dr. Adeney, Mr. K. B. Elles, and others took part.

SECTION D.—ZOOLOGY.

Presidential Address by Dr. S. F. Harmer, F.R.S.

Discussion on "The abuses resulting from the strict application of the rule of priority in zoological nomenclature, and on the means of protecting well-established names." Opened by Mr. G. A. Boulenger, F.R.S.

Professor Cossar Ewart, F.R.S.—Wild Ancestors of the Domestic Horse.

Lantern Lecture by Dr. A. Smith Woodward, F.R.S.—The Evolution of Fishes.

SECTION E.—GEOGRAPHY.

Presidential Address by Major E. H. Hills, C.M.G., R.E.

Professor W. M. Davis.—The Physiographic Subdivisions of the Appalachian Mountain System.

Rev. W. Spotswood Green.—Ireland: her Coasts and Rivers.
Dr. W. S. Bruce.—Scientific Results of the Voyage of the "Scotia."
Captain H. G. Lyons.—The Longitudinal Section of the Nile.
Rev. G. Furlong.—Unique Experiences at the Birth of a Volcano.
H. Brodrick.—The Marble Arch Caves, Co. Fermanagh.
Dr. C. A. Hill.—Mitchelstown Cave.

SECTION H.—ANTHROPOLOGY.

Presidential Address by Professor William Ridgeway, M.A., LL.D., Litt. D., F.B.A.
C. T. Currelly.—A Sequence of Egyptian Flint Implements.
Professor G. Elliot Smith, F.R.S.—Anthropological Work in Egypt.
Rev. Dr. Bryce.—The Mound Builders of North America.
Rev. W. A. Adams.—Some Ancient Stone Implement Sites in South Africa.
Dr. N. Gordon Munro.—Prehistoric Archæology in Japan.
Dr. R. F. Scharff.—Some Remarks on the Irish Horse and its early History in Ireland.

SUBSECTION.—PHYSICAL ANTHROPOLOGY.

J. Gray.—Who Built the British Stone Circles?
Miss Nina F. Layard.—An ancient Land Surface in a River Terrace at Ipswich and a Palæolithic Site in the Valley of the Lark.
Report of the Committee to conduct Explorations with the object of ascertaining the Age of Stone Circles.
Report of the Committee on the best means of Registering and Classifying systematically Megalithic Remains in the British Isles.
G. Clinch.—On the Classification of the Megalithic and analogous Prehistoric Remains of Great Britain and Ireland.
Report of the Committee to Investigate the Lake Village at Glastonbury.
W. J. Knowles.—Perforated Stone Hammers and Axes.

II.—ON THE CAVE OF CASTLEPOOK, NEAR DONERAILE, CO. CORK.[1] By R. J. USSHER, H. J. SEYMOUR, E. T. NEWTON, and R. F. SCHARFF.

CASTLEPOOK Cave, north of Doneraile, leads into an extensive series of deep parallel galleries in limestone. Most of them are narrow, with vertical sides up to a certain level, where the walls recede with a wide sweep, forming an arched tunnel. Near the top of this the galleries are still spanned in places by an ancient stalagmite floor. Some of the sand on which the latter was formed is still adhering to it underneath. Beds of sand filled the lower parts of many galleries. This sand contained, sometimes down to 12 feet, numerous remains, chiefly of reindeer.

The geological evidence as to the age of the cave is unsatisfactory. Only rolled and unstriated pebbles have yet been discovered in the cave and no foreign erratic. This would seem to indicate that the material now in the cave, and hence the cave itself, is pre-Glacial in age, for otherwise a pebble of the granite known to be widely

[1] Read before the British Association, Section C (Geology), Dublin, September, 1908.

distributed throughout the overlying boulder-clay might reasonably have been expected to occur amongst the large number of boulders found in the various passages. No such pebble has, however, been found. The inference, therefore, on more or less negative evidence, is that the cave was formed in pre-Glacial times.

The bird remains found in the cave call for no special remarks. More than half are referable to the domestic fowl, turkey, and duck, though some of the latter may belong to the wild form. Like the bones of the rook, which are also numerous, they may have been brought in recently by foxes. The remainder all belong to such species as are now found in the neighbourhood.

The mammalian remains are of a very different character. It is true that the bones of the rabbit, sheep, ox, horse, pig, fox, cat, and rat seem mostly of comparatively recent origin. By far the greatest number of the bones found belong to the reindeer and bear. The exceedingly numerous bone splinters, the gnawed bones of reindeer, and the presence of many bones of old and young hyænas seem to indicate coexistence in Ireland of the latter and the typically Arctic species. The hyæna, which had not previously been known to have ever inhabited Ireland, is closely related to that now living in South Africa. Other animals, whose remains were probably dragged into the cave by hyænas, are the mammoth, Gigantic Irish deer, red deer, and wolf. Among the smaller mammals the bones and teeth of the Arctic Lemming (*Dicrostonyx torquatus*) and of the Scandinavian Lemming (*Lemmus lemmus*) are very abundant. They may have been brought in by the Arctic fox.

No human remains or implements were found except parts of modern iron tools and charred wood, indicating the presence of man only within quite recent times.

In so far as Ireland is not generally believed to have been joined to England by land in Glacial or post-Glacial times, the presence in the country of the mammoth, Gigantic Irish deer, and hyæna apparently confirms the opinion, arrived at from geological evidence, that Castlepook Cave must be a pre-Glacial one. This view is supported by the absence of many animals from Ireland which seem to have made their first appearance in England during the Glacial period.

III.—Probable Cretaceous and Cainozoic Outliers off the Coast of Co. Kerry.[1] By Professor Grenville A. J. Cole, F.G.S.

THE dredgings made since 1901 by the Fisheries Branch of the Department of Agriculture and Technical Instruction for Ireland have amply supported the conclusions then put forward,[2] to the effect that the geological structure of the sea-floor off western Ireland can be deduced from a study of the stones lying on it from point to point. The most interesting recent results are the discovery of abundant flints, chalk, glauconitic chalk, and two specimens of Milioline limestone in dredgings off the coast of Kerry. Mr. Worth's observations in 1908 on similar materials in the English Channel thus receive

[1] Read before the British Association, Section C (Geology), Dublin, Sept. 1908.
[2] Cole and Crook, Report on Fisheries of Ireland for 1901.

confirmation from areas much further west, and it is clear that both the Cretaceous and Eocene seas extended to an unknown distance in that direction, though we can trace their boundaries fairly on the north-west. Many of the flints of southern Ireland may have been derived from local strata rather than from ice-borne drift.

IV.—On a Section of the Lower Coal-measures at Emerald Pit, Dungannon.[1] By H. Bolton, F.R.S.E., F.G.S.

A SHAFT was sunk in 1894–5 some little distance to the north of the old Drumglass colliery, and was carried to a depth of 197 yards, penetrating five coal-seams before reaching the Main Coal, which was known to the miners as the 'Congo' seam. During the course of the sinking a measured section was obtained of the strata passed through, and a collection of fossils brought together. After work had commenced on the deeper coal-seams, water broke into the colliery on two occasions, causing its abandonment. A generalised section of the measures passed through is as follows:—

		yds.	ft.	in.
	Strata	46	2	7
1.	Coal (inferior)		1	10
	Strata	3	2	2½
2.	Coal			½
	Strata	65	2	3
3.	Coal (in thin partings with shale)	2	0	5
	Strata	44	0	11
4.	Coal			3
	Strata	25	0	5
5.	Top Coal 1 ft. 0 in.; Brown Shale 7 in.; Coal 1 ft. 3 in.; Interior Coal 3 in.; Coal 9 in.	1	0	10
	Strata	5	0	6
6.	Coal	3	3	

Down to the level of the fourth coal, the strata consisted mainly of red, yellow, and grey sandstones, with grey bind partings. Below the fourth coal, black and grey shales predominated. At a depth of 133 yards from the surface occurred a black shale containing a typical Lower Coal-measures marine fauna.

The following species have been determined:—

Brachiopoda.
Discina nitida.
Lingula squamiformis.
Spirifera trigonalis.
Camarophoria isorhyncha?
Chonetes sp.

Pelecypoda.
Sanguinolites plicatus, Portlock.
Nucula gibbosa.
Nuculana attenuata.
Protoschizodus aximiformis.
Parallelodon cf. *Verneuillianus*, de Kon.

Gasteropoda.
Pleurotomaria cf. *gemmulifera.*

Cephalopoda.
Orthoceras Koninckianum ? d'Orb.

Vermes.
Serpulites membranaceus.

Fishes.
Palæoniscid scale and tooth.

[1] Abstract of paper read before British Association in Section C (Geology) Dublin, September, 1908.

V.—Notes on the Petrography of Egypt.[1] By W. F. Hume, D.Sc.

1. The ancient core of the North-East African Continent consists of the Cataract and Sudan Banded Gneisses, which may represent a very ancient igneous magma. They are usually much veined by granitic dykes.

2. In certain places in the Arabian Desert, Cataracts, etc., these underlie highly metamorphosed Schists (the Mica-Schists of Sikait, the Calcareous Schists of Um Garaiart and Haimar and of the Amara Cataracts, also the Dolomites of the latter region), which are sharply separated from the Banded Gneisses, and are possibly the oldest sedimentary representatives in Egypt.

3. The greater part of the mountainous regions of the Eastern Desert and Sinai is occupied by two types of rock, (*a*) a schistose constituent overlying or surrounded by (*b*) an acid member. The first-named (*a*), the Dokhan Volcanic Rocks and Schists, are partly volcanic in origin and partly sedimentary, the former being represented by lavas of various types, while the latter are clearly altered sedimentary strata (grits, conglomerates, etc.). No fossils have yet been found, but they have their nearest analogues in the latest Pre-Cambrian and Cambrian series. Here are included some of the most interesting rocks of Egypt, such as the Imperial Porphyry and the Breccia Verde Antico.

(*b*) The igneous member intruded into these ancient sediments, etc., includes a great diversity of igneous rocks, varying from highly basic to acid types. Contact phenomena of complex nature occur at the junctions of *a* and *b*.

4. Red Granite and Dyke Rocks, whose parallelism and extent of distribution present one of the most conspicuous features of the Eastern Desert of Egypt, mark the final eruptive action before Carboniferous times.

5. Three periods of volcanic activity have been subsequently noted.

(*a*) In Western Sinai in late Carboniferous times.

(*b*) An undated series of eruptions interbedded with the base of the Nubian Sandstone or intrusive into it with marked contact alterations.

(*c*) The Basic intrusions near Cairo and the Fayum, etc., which are intimately associated with the Oligocene Continental Period in Egypt.

VI.—The Tourmaline Rocks of Cwm Dwythwc, near Llanberis (North Wales).[1] By W. G. Fearnsides, M.A., F.G.S.

SOME years ago, when examining sands from the neighbourhood of Caernarfon, I found that both the river sands of the Seiont and the beach sands of the Menai contain tourmaline. In order to trace the mineral to its source I have since examined the heavy mineral residues of the sands of nearly all the tributaries of the Seiont, and find that all those which flow across the Cambrian Slate Belt contain either needles or broken grains of brown tourmaline. The sand from

[1] Read before the British Association, Section C (Geology), Dublin, Sept. 1908.

the Afon Arddu (whose delta parts the two lakes of Llanberis) is exceptional, and is very rich in well-formed trigonal prisms of blue tourmaline. The sand from the Afon Hwch, its tributary from between Moel Eilio and Moel Goch, is even more surprising, and in the sand from the spits along the flatter reaches of this burn tourmaline can generally be distinguished with a pocket lens.

I have therefore mapped the Cwm Dwythwc on the 6 inch scale, and in mapping have found the tourmaline rocks *in sitû*. They are mostly coarse grits, grits, flags, and slaty flags, and occur along the horizon of the unconformity between Cambrian and Ordovician rocks. The tourmaline is not clastic, but has been formed *in sitû* from the felspathic ground-paste of the grits or flags, and clustered new-formed needles enter and pierce the quartz pebbles of the grit or the chloritoid ground-mass of the slate in a most fascinating manner. There has been thrust-faulting along the unconformity, but no large intrusive mass of igneous rock has been observed within five miles of the locality. Tourmaline new-formed in the slate and the remains of tuning-fork graptolites can be found within 3 or 4 inches of each other. The tourmaline is a soda-bearing variety.

VII.—The Derivation of Sand and Clay from Granite.[1] By Professor W. Boyd Dawkins, D.Sc., F.R.S.

THE decomposition of granite by the attack of carbonic acid in the rain-water on the soluble crystalline constituents of the granite results in the formation of a surface covering more or less complete over the solid rock which can only be studied in non-glaciated regions. It is conspicuous by its absence from the ice-swept granite areas of the Lake country, of Scotland, and of Ireland, and of Middle and Northern Europe.

The quartz in the granite has resisted decomposition, and where the finer products of decomposition have been swept away it forms a coarse sand, each grain presenting an irregular surface indented by the felspars and micas as they cooled from the heated magma. These are traceable more or less through a large number of sandstones, and more especially through those of the Millstone Grits and Coal-measures of Middle and Northern England.

The attack of the rain-water containing carbonic acid on the micas results in the decomposition of the biotite and to a lesser degree of the muscovite, while the soluble felspars, such as orthoclase, are completely dissolved, constituting hydrated silicates of alumina and new minerals such as kaolinite and secondary minutely crystalline muscovite. All these occur in the china clay of Cornwall and Devon, and are invariably associated with grains of quartz, primary mica, and tourmaline present in the unaltered granite. These constituents occur in all the samples ranging from the purest china clay through the whole series which have as yet been examined, with the addition of others of local derivation.

[1] Read before the British Association, Section C (Geology), Dublin, Sept. 1908.

These facts indicate that granite has been one of the chief sources, not merely of the arenaceous, but also of the argillaceous rocks. It is not improbable that both may ultimately be proved to have been derived from the siliceous acid layer believed by Durocher and Haughton to have been the first to become solid in the cooling globe.

VIII.—Glacial Erosion in North Wales.[1] By Professor W. M. Davis.

THE mountains of the Snowdon district are believed to represent a group of monadnocks which surmounted the peneplain to which a large part of the region was reduced in Tertiary time. The valleys between the monadnocks were somewhat deepened by normal erosive processes, in consequence of a general elevation of the region in late Tertiary time. As a result, the topography of the Snowdon district in immediately pre-Glacial time may be described as exhibiting a group of well-subdued mountains, drained through valleys of somewhat sharpened form. The difference between the forms thus described and the forms seen to-day in the Snowdon district is very great, both in amount and in kind, and cannot be accounted for by normal erosion during Glacial and post-Glacial time. But the difference is, in amount and kind, just what might result from glacial action, if it be postulated that glaciers are effective eroding agencies. The depth of glacial erosion in certain cwms and valleys is believed to have been 400, 600, or 800 feet; the breadth of glacial erosion must have been of even greater measure.

IX.—The Duration and Direction of Large Earthquakes.[1] By Dr. John Milne, F.R.S.

SMALL earthquakes, as for example those which occur in this country, have a duration of a few seconds near to their origin. At places 50 or 100 miles distant they may not be recordable. The duration, therefore, has varied between a few seconds and zero. With many large earthquakes, however, this decay during transmission is not appreciable, and duration near to their antipodes may be as great as it is near to their origin. Duration as one of these disturbances travel, rather than decreasing, at times appears to increase. The greatest duration is at about 90° distance from an origin. That which occurs may be compared with what we observe after a flask of water has been tilted. The contents oscillate like a pendulum, and any one part of the fluid comes to rest about the same time as any other part.

Another observation in connection with recent seismological observations is that large earthquakes travel farthest in particular directions. I have taken seventy-nine large disturbances with fairly well-known origins south of the Caucasus, north of India, and to the east or south of Japan. These earthquakes have travelled farther to the west than to the east, and there has only been a small percentage of them that have found their way across the equator to observatories in the southern hemisphere.

[1] Read before the British Association, Section C (Geology), Dublin, Sept. 1908.

X.—The Soufrière of St. Vincent: The Changes subsequent to the Eruption of 1902.[1] By Tempest Anderson, D.Sc., F.G.S.

In 1902 the author visited St. Vincent, along with Dr. Flett, after the then recent eruption. In 1907 he revisited the island and examined the changes that had taken place in the new deposits.

In 1902 an incandescent avalanche descended into the valleys which occupy the great transverse depression across the island to the south of the Soufrière, and in particular the Wallibu Valley was filled for a great part of its course to a depth of at least 100 feet, but less near its mouth. In this deposit of red-hot material the secondary phenomena of re-excavation of the valley by the river, the falls of hot ash, the steam explosions, and the flows of boiling mud took place, and are described in the Report, Part I.[2] In 1907 almost the whole of this ash had been washed away, but a fragment remained in the shape of a terrace, 60 to 80 feet high, situated on the north side of the valley. The ash of which it is formed is unstratified, and contains very few ejected blocks or fragments of any kind. The floor of the valley is all composed of water-sorted material, chiefly gravel and coarse sand, but with a good many blocks as big as a man's head. They represent ejected blocks and fragments of lava derived partly from the ash of 1902 and partly from older beds, the fine ash in each case having been washed away. The surface of the gravel-bed showed marks of quite recent running water, and during the last Winter (1906–7) the river ran along the foot of the north bank of the valley. When examined in March, 1907, it ran along the south side of the valley, and had already in those few months excavated a new channel about 30 feet in depth. The stratification, as exposed in this new valley, is very distinct, and the sorting by water, mentioned above, is very evident. Further up the mountain the remains of the avalanche became more abundant in the valley bottoms, and here they were also better preserved, so that traces of the feather-pattern erosion, so noticeable in 1902, were still visible on the surface. This was mainly due to the surface of these ash deposits, like those to be presently mentioned on the plateaux and on the ridges, having consolidated into a crust, almost like a cement pavement, which resists the action of the rain.

Another interesting point was observed with regard to these massive beds of recent material. Instead of one stream re-establishing itself along the centre of the deposit, the tendency is for a new stream to form on each side at or near the junction of the new ash with the old valley slopes; and as these streams deepen their beds two new valleys are formed where only one previously existed, and the walls of each are composed on the one side of the new ash and on the other of older tuff, with occasional terraces.[3]

An account was also given of a visit to Montagne Pelée, in

[1] Abstract of paper read at the British Association in Dublin before Section C (Geology), September, 1908.

[2] Anderson & Flett, Phil. Trans., 1903, Series A, vol. 200; Anderson, Geographical Journal, March, 1903.

[3] See, further, Anderson, Report, Part II, Phil. Trans., Series A, vol. 208, pp. 275–300; Flett, Petrology, ibid., pp. 301–35.

Martinique, with a discussion of the phenomena of the extrusion of and subsequent destruction of the spine which have been described by Lacroix and others, and a comparison of the eruptions of the two islands.

XI.—On the Finding of Silurian Beds in Kent.[1] By W. Whitaker, B.A. (Lond.), F.R.S.

A BORING has lately been made, to a great depth, at Messrs. Curtis & Harvey's works, on the Thames Marshes at Cliffe, for the purpose of getting a supply of water, firstly from the Chalk and then from the Lower Greensand. It has failed in this, the water from both formations being too salt to be of any use; but it has succeeded in adding a geologic formation to the Kentish list, and that the oldest yet found in the county.

Details of the section will be given in a forthcoming Geological Survey Memoir on the Water-supply of Kent. It should be noted that the division between some of the formations is doubtful, but any error from this cause is immaterial in the following abstract:—

	Feet.	
Alluvium and River Gravel . .	77	
Upper, Middle, and Lower Chalk .	656 (or more)	
Gault	208 (or less)	1,074 feet.
Lower Greensand	96 (or less)	
Dark-grey clayey rock . . .	37 (or more)	

Nearly the whole of the Chalk has been pierced, the topmost part only being absent. The thickness given to the Gault is a little more than in the borings at Chatham, Frindsbury, and Strood eastward, and still more than at Erith (Crossness) westward. The thickness given to the Lower Greensand is also more than at Chatham, whilst at Erith there is none of this formation.

The chief interest of the boring, however, lies in the facts that the floor of the older rocks, which has been proved in many places in Kent, was reached at a level of about 1,030 feet below Ordnance Datum, and that the Palæozoic formation found is of Silurian age, nothing older than Devonian having been hitherto recorded from the deep borings of the county, and that only at Brabourne, unless the red rocks at Crossness should turn out to be of like age.

The proof of the Silurian age of the lowest beds is given by the occurrence of fossils at the depth of 1,063 feet, *Atrypa reticularis* and *Plectambonites* having been determined at the Palæontological Department of the Geological Survey by Mr. H. A. Allen, from samples of the cores sent by Mr. Baldwin Latham. There are traces of other fossils.

The practical value of the boring is that it puts a northern limit to the Kent coalfield in its neighbourhood.

XII.—On a case of Thrust and Crush-brecciation in the Magnesian Limestone, Co. Durham.[1] By David Woolacott, D.Sc., F.G.S.

ALONG the two miles of cliff between South Shields and Marsden the breccias that formed so marked a peculiarity of the Magnesian Limestone of North-East England are best exposed. The rocks seen are

[1] Read before the British Association, Section C (Geology), Dublin, Sept. 1908.

the yellow sands, marl slate, and Magnesian Limestone, but the effect of the thrust on the first two cannot be observed. The limestone, although much disturbed, has a general low dip to the south. It consists of a series of rocks of different flexibility, rigidity, brittleness, and compressive strength, and the uniqueness of the section is due to the action of a thrust from the north, which has caused some of the beds to move laterally upon the others, with an associated production of folding, minor-thrusting, and fissuring, and a consequent development of dynamic brecciation.

In Frenchman's Bay the lower limestone (40 feet thick) is a brownish-yellow, regularly bedded rock of relatively high compressive strength and rigidity. Its lower layers are gently folded, but its top layers are considerably disturbed, being fractured, tilted up, and laterally displaced. Resting on this is about 50 feet of brecciated limestone, consisting almost entirely of a cemented mass of broken fragment, which have here and there been dissolved out from the cementing matrix, the rock becoming cellular. In places the bedding, unfolded but fractured, is still preserved. It was originally a finely laminated granular limestone, and is of low rigidity and compressive strength. Experiments performed by Dr. Morrow give the following results:—Compressive strengths (tons per square inch to break rock), lower limestone, 5·7 tons; brecciated bed (lower middle), 1 ton.

The junction of the brecciated beds with the lower limestone is a thrust-plane, which does not always coincide with the line of demarcation between the two strata; and the disturbance of the upper layers of the latter rock, together with the smashing up of the former, is due to the thrust movement.

The brecciated beds occupy the top of the cliff for over a mile. Their upper surface, which is seen at the north end of Marsden Bay, is very irregular and hummocky, the breccia having been forced up into the base of the beds above. These consist of about 200 feet of rock differing much in flexibility and compressive strength (specimens tested vary from 1 ton to 37 tons per square inch). They have been thrust against a 'Horst,'[1] and consequently folding, thrusting, and dynamic brecciation have taken place. The flexible beds have been deformed without being much broken, while a harder, more brittle, wedge-shaped limestone has been highly brecciated. The latter has also had a coarse cleavage structure impressed on it, and part of it has been torn off and thrust into the beds above. Breccia gashes and vertical fissures filled with breccia, which has fallen into them, occur on both sides of this folded and broken area. The amount of lateral displacement at this point has probably been about 100 yards, and the experiments indicate that the magnitude of the thrust was about 300 tons per square foot.

[1] 'Horst,' see Suess, "Antlitz der Erde," 1st ed. (1885), vol. i, p. 167, and also Maria Ogilvie, Quart. Journ. Geol. Soc., 1893, vol. xlix, p. 77, for explanation of term.

XIII.—The Laterite and Bauxite Zone of North-East Ireland.[1]

By Professor Grenville A. J. Cole, F.G.S.

THIS paper was merely explanatory of an exhibit of the types of rock formed during the interval between the basaltic eruptions in the north of Ireland in Eocene times. It was urged, in agreement with the views of Richardson and Tate and Holden, that the red lateritic zone represents basalt altered *in sitû* even down to depths of 40 feet, the so-called 'volcanic bombs' in the layer being residual lumps of less altered basalt. Such a type of alteration is clearly connected with the climatic conditions of Eocene times. Some of the pisolitic iron-ore may have accumulated on the surface of the laterite in pools formed during the rainy seasons. The pale bauxites are derived from sporadic eruptions of rhyolite, and the bi-pyramidal crystals of quartz in them prove this over a wide area. The thin bauxitic layer, occurring as it does above the pisolitic iron-ore, may be in part formed by wind-borne material.

XIV.—On some Fossil Shells from Comparo Road, Trinidad.[2]

By R. J. Lechmere Guppy.

AMONG the fossils submitted to me for determination at different times by Mr. E. H. Cunningham-Craig, F.G.S., lately Government Geologist, was one collection of peculiar interest consisting of fresh-water shells of genera and species not now found in Trinidad, and forming a fauna completely distinct from any now existing here. The locality given me was Comparo Road. I furnished Mr. Craig with the names of the shells and notes on them, but I think it as well to put on record the names of these fossils.

1. *Hemisinus sulcatus*, Conrad.

Amer. Journ. Conch., 1870.

Conrad considers *H. tenellus* to be a near ally of this shell. It is, however, very closely akin to *H. bicinctus*, Reeve, an existing species of South American rivers. *Melania cingulata*, Moricand (Journal de Conch., 1860, pl. xii, fig. 6), and *M.* (*Melanopsis*) *brasiliensis*, Mor. (ibid., pl. xii, fig. 7), are also very near.

2. *Leptoxis crenocarina*, Moricand.

An inhabitant of Brazilian rivers. A remarkable and aberrant form of *Melania*.

3. *Anodon batesii*, H. Woodward.

Ann. Mag. Nat. Hist., 1871–4 ser., vol. vii, p. 103, pl. v, fig. 10.

There is no need to go to Asia for the nearest analogue of this bivalve, which is related to the *Anodon leotaudi* of our rivers and equally so to *A. sirionos*, Orb., and *A. puelchana*, Orb., of South America. The African shell figured under the name of *Margaritana pfeifferiana* by Bernardi (Journal de Conch., 1860, pl. xii, figs. 1, 2) bears much likeness to the species named, which are all closely related.

[1] Read before the British Association, Section C (Geology), Dublin, Sept. 1908.
[2] Bulletin Botanical Department, Trinidad, July, 1908, Article No. 1005.

4. *Cyrena semistriata*, Desh.

I had attached the manuscript name of *craigiana* to this shell, but a closer comparison of the numerous specimens contained in a slab presented by Mr. Craig to the Victoria Museum caused me to feel doubtful whether it ought to be accounted distinct from the *C. semistriata* of the European Tertiaries (Pictet, Paléontologie, pl. lxxvi, fig. 10; and Forbes, Isle of Wight, pl. iii, fig. 2). It is akin to *C. solida*, Phil., of Central American rivers.

5. There is also a very remarkable bivalve whose fragmentary condition prevents determination.

The collection indicates fluviatile or estuarine conditions, and has resemblances to the Tertiary deposits of the Amazons valley, whose fauna has been described by Conrad (Amer. Journ. Conch., 1870) and H. Woodward (Ann. Mag. Nat. Hist., 1871). I am of opinion that a Pliocene age is denoted.

Note.—In addition to the papers referred to by H. Woodward in the place above cited, there is a paper by Etheridge in the Quarterly Journal of the Geological Society of London, 1879, vol. xxxv, pp. 82–8, on fossils collected by Barington Brown in the Amazons valley.

XV.—On the Cement-producing Materials of Naparima, Trinidad.[1]

By R. J. Lechmere Guppy.

WHEN I retired from office under Government at the beginning of 1891, I undertook an examination of the rocks of Naparima in Trinidad. These formations had occupied my attention at intervals ever since 1859, when I first studied them. The discovery of the wonderful series of Foraminifera, of which I had previously gained only a glimpse in 1872, was the first reward of that examination; but as a collateral result I found that we had here a very extensive series of deposits apparently suitable as material for the manufacture of cement. I inquired of the Public Works Department if this information would be of any use to them, more especially as the beds passed through and were developed on Government lands. The reply I got was that all the cement wanted could be furnished by the Crown Agents for the Colonies and there was no need of any local supply.

The results of my examination of the Naparima rocks were embodied in a paper read to the Geological Society of London and published in their Journal, November, 1892, p. 519.[2] In that paper I casually mentioned the occurrence of cement materials in these rocks in these words (p. 530): "I think it highly probable that in some of the marls we have a material suitable for the manufacture of cement." It was not until this paper was before the Geological Society that I was aware that Messrs. Harrison and Jukes-Browne had been working at the geology of Barbados and had read a paper thereon before the Society. These gentlemen were good enough to forward to

[1] Bulletin Botanical Department, Trinidad, July, 1908, Article No. 1006.

[2] See Geol. Mag., 1892, p. 331, and a further paper in Geol. Mag., 1900, pp. 322–5.

me a copy of their highly interesting and elaborate paper (Journal Geological Society, London, 1891, p. 198, and 1892, p. 170), which showed that there was a remarkable similarity between the rocks of Barbados and those of Naparima. But it was not even then, but a couple of years later, that I became aware of the existence of cement-producing materials in the oceanic rocks of Barbados similar to those of Naparima. Professor Harrison had the kindness to send me, what I had not seen before, a copy of the report prepared by him in conjunction with Mr. Jukes-Browne on the geology of Barbados for the Government of that island. In this they say:—

"The lowest chalky beds of the oceanic series possess a value which is derived partly from their chemical composition and partly from the fact of their lying immediately upon the dark clays. In these deposits we have the materials for the manufacture of cement. We believe the cement-making will be, if the suggestion is followed up with energy, one of the most promising of the industries of the island. We may mention that there are other beds of chalky earth which would be equally suitable for the manufacture of cement, and, further, that there are beds of dark-grey earth consisting partly of chalky earth and partly of fine mud, which have a chemical composition that seems to indicate their suitability for making cement without any admixture of clay."

Beds of the identical composition of those referred to in the foregoing extract occur in the Naparima district. It is matter for trial and experiment merely which of them is best for the manufacture of cement. My own opinion is that the softer beds will be the best, but some of them may require to be mixed with more argillaceous material, which can easily be obtained from the other beds in the neighbourhood. It is probable, however, that a material will be found which will give the right proportions without any admixture.

During my investigation of the Naparima rocks, particularly in 1891, I was struck by the remarkable resemblance in composition between these rocks and those from which cement was manufactured as described by various authorities. I have not at present by me all the works I have consulted on the subject, but it will suffice to refer to the United States Geological Reports, namely, the 20th Annual Report (1898–9), the 21st Annual Report (1899–1900), p. 402, and the 22nd Annual Report (1900–1), p. 728. According to these the average composition of the material for the best quality of cement is practically the same as found in the Naparima deposits.

REVIEWS.

I.—Catalogue of Minerals in the Technological Museum of the South Australian School of Mines and Industries. Compiled by Herbert Basedow, Honorary Curator. pp. 200. Adelaide: C. E. Bristow, 1907.

IT is evident from the Catalogue which has been carefully prepared by Mr. Basedow that the South Australian School of Mines possesses a collection of minerals well adapted to the purposes of

teaching. Numbering about 25,000 specimens, it includes all the important mineral species, South Australian minerals being, of course, well represented. The species are classified according to the arrangement adopted by Dana in the sixth edition of the "System of Mineralogy," and the information contained in the Catalogue comprises the registered number of each specimen, its locality when known, the source through which it was obtained, and occasional remarks of general interest.

II.—A Pocket Handbook of Minerals. By G. Montague Butler. pp. ix + 298, with 89 figures in the text. New York: John Wiley & Sons, 1908. Price 12*s.* 6*d.* net.

TO those who have to arrive at a rapid determination of mineral specimens—for instance, prospectors and other workers in the field—the convenient handbook prepared by Professor Butler will prove welcome. In it he gives for each species the physical characters, such as the colour, lustre, hardness, and streak, that are observable almost by mere handling of the specimen, and the reactions that may be determined by means of the ordinary blowpipe and simple reagents included in any prospector's outfit, the more important and decisive tests being emphasized by a judicious use of heavy type. The various characters are summarised in tables printed at the end of the book on folding sheets of paper, an inconvenient arrangement that would probably not stand the wear and tear of constant use. Ample space is left for the addition of notes that experience may suggest, and the book is well illustrated with sketches of characteristic crystals and pictures of typical specimens. The additional chapters dealing respectively with the commercially important ores of the various metals and with the average retail prices of gem-stones and minerals will be valuable to the prospector, and the ample glossary will be useful to those not conversant with the technical terms in vogue among mineralogists. The arrangement of the mineral species follows closely Dana's well-known treatise, from which, indeed, the information given has been mainly culled.

The value of the book would have been greatly increased by the addition of numerical data, such as the specific gravity, which is given only in cases where it is an obviously distinctive character, and the refractive constants. Methylene iodide has been so much reduced in price of late years that an ounce or so is no serious addition to the expense of an outfit; even without a dilutant it may after a little experience be employed to give valuable information. Now that portable refractometers are available it is possible to determine in the case of most transparent substances the refractive indices, often a satisfactorily decisive test.

III.—Brief Notices.

1. Plumbago.—It is singular to find how little one knows about the most ordinary things, and Dr. J. W. Evans must be congratulated in having, at the instance of Dr. Murray, cleared up the history of the

word Plumbago. But it has required 47 pages of the Philological Society's Transactions for 1908 to tell the story. The earliest use of the word seems to occur in Pliny (Hist. Nat., v, 95), where, quoting from Dioscorides, he says, "quidam limatum plumbum sic terunt, quidam et plumbaginem admiscent." 'Plombagine' occurs in Cotgrave, French and English Dictionary, 1611, but the first English use of 'plumbago' is believed to be seen in John Woodall's "Surgion's Mate," 1617, p. 113, where the word is explained as "Plumbago, or red leade, hath the force of binding, mollifying, filling up hollow ulcers with flesh." The paper is of extreme interest, not only from the care with which it has been prepared, but from the light it throws on the early history of mineralogy, for the history of Plumbago may be taken as a type of that of any other mineral.

2. Local Societies.—Mr. W. G. Clarke has a paper on the "Distribution of Flint and Bronze Implements in Norfolk," and Mr. Frank Leney writes on "Some Additions to the Norwich Castle Museum in 1906," in the Trans. Norfolk and Norwich Nat. Soc., vol. viii, pt. 3. None of these accessions are of geological interest. Mr. Clarke's paper is most useful, as it gives information as to the present resting-place of the specimens and where they were described. The Trans. Edinburgh Geological Society, vol. x, pts. 1 and 2, includes papers "On the Mineralogy of the Faeröes, arranged topographically," by James Currie; "Volcanic Tuffs on Ben Nevis," by Wm. Mackie; "Fossils and Conditions of Deposit, a theory of Coal formation," by C. B. Crampton; "Contemporaneous Volcanic Action in the Banffshire Schists," by Wm. Mackie; "New Localities for Oil-bearing Shale near Edinburgh," by Crampton & Tait; "Recent Progress in Seismology," by C. G. Knott; "Geology of Malcolm," by R. Campbell & A. G. Stenhouse; and "Egg-shaped Stones dredged from Wick Harbour," by D. Tait. These curious egg-shaped stones are considered by Mr. Tait to be rolled concretionary nodules of Jurassic age.

3. Museums.—We call the attention of our readers to an able article on the present position at the British Museum (Natural History), which appears in the August number of the *Museums Journal*, *à propos* of the letter signed "Wilfred Mark Webb" which appeared in the *Times*, 10th July last.

The Report of the Borough of Colchester Corporation Museum, 1908, shows a good deal of activity chiefly in an archæological direction. Many important local finds are listed, and some of the more interesting have been photographed and sold as postcards. This photography of all objects of interest cannot be too greatly persevered in, as the pictures are valuable to others who cannot obtain the real thing. When, moreover, they are utilized as postcards, there is every chance of their paying for themselves, and thus confounding one of the chief difficulties of local authorities.

The Report of the Ruskin Museum for 1908 lists as an accession to the mineral collection a "specimen of laminated talc containing arborescent pyrolusite." Beyond that all additions have been artistic or literary.

The Manchester Museum has arranged the "Mark Stirrup" collection, a series of Coal-measure plants from the Radstock series, and is now taking in hand the Cretaceous collection, which was sadly in want of attention. Among noteworthy accessions is the Thomas Parker collection of Carboniferous fishes and Brachiopods, containing types figured by Mr. J. W. Davis and Dr. Thos. Davidson. The geological library has been enriched by Mr. Stirrup's books, and a large collection of stone implements presented by Mr. R. D. Darbishire.

The Museum of the Yorkshire Philosophical Society has appointed the Rev. W. Johnson as curator in the place of the late J. F. Walker. The Tertiary fossils have been re-labelled, but we hope the original labels have in every case been kept. The geological department did not receive a single accession during 1907–8. The "Report" is mainly archæological, save Dr. T. Anderson's paper on the Volcanoes of Guatemala, which has been reprinted from the Geographical Journal.

Rugby School Museum has acquired, through the generosity of the Hon. E. C. Fraser, a collection of bones of the Dodo and the Solitaire.

We learn from the *Naturalist* that Beverley in Yorkshire will soon have a local museum.

4. Ice.—Mr. J. G. Buchanan's lecture on Ice to the Royal Institution of Great Britain in May last has now reached us. Full of suggestive and interesting matter and well illustrated, we can only find room to call attention to the chief headings dealt with. These are the nature of the ice formed by freezing saline solutions; the distinction between the melting-point of a substance and the temperature at which it melts under given conditions; the influence of salt in inducing the melting-point of ice; cryoscopic equivalence between pressure and salinity; influence of impurity on the apparent latent heat of ice; glacier grains; their size; sun-weathering of granular ice produces white surface of glacier; snow nevé and glacier; lake ice; its grain; characteristics of an advancing glacier; grooving of ice by rock; and external work of a glacier. The author concludes his printed lecture with an explanation of "the real region of mechanical erosion and attrition is the seashore," with a note on the advantage of study of tropical lands, and refers to the 'Crumble' formation. He lays down the law that "the chemical action of atmospherical moisture and the tendency of every part of a mountain or rock to yield to gravity when not adequately supported, suffice to account for all the degradation of rock which we observe." Excellent photographs of granular ice, of a stream-bed after three rainless years and on the same day but after a violent rainstorm, and of the chemical and gravitational degradation of the mountain slopes at the back of Antofagasta, Chili, where the landscape consists of a succession of taluses in a rainless district, are given.

5. Geological Survey of New Jersey.

Annual Report of the State Geologist for the Year 1907. 8vo; pp. 192. Trenton, N.J., 1908.

The bulk of this volume is occupied with J. V. Lewis' Petrography of the Newark Igneous Rocks, illustrated by many plates of field

occurrences and their sections. The other portion of the volume consists of reports on an Inland Waterway from Cape May to Bay Head, by H. B. Kümmel, with estimates by Vermeule and Haupt. Detailed maps are also given.

6. Ceylon.

Ceylon, a Handbook for the Resident and the Traveller. By J. C. Willis. 8vo; pp. 246, map, and many illustrations. Colombo, Colombo Apothecaries' Co.; London, Dulau & Co., 1907.

This book provides information on the Geology, Geography, Climate, Zoology, Botany, Forests, and Irrigation, besides the History, People, and Archæology of the Island. The scientific matter is sketchy, and the zoology needs expansion. Several pages are filled with notes on the mineral products, and among the illustrations is an excellent picture of a graphite mine taken by Mr. Coomaraswamy. To anyone visiting this delightful island the book should be indispensable.

7. Maryland.

Maryland Geological Survey: Vol. VI. 8vo. Baltimore: John Hopkins Press, 1906.

This volume deals with the physical features of the State by W. Bullock Clark and E. B. Matthews, and gives a general summary of the geology under formations, the mineral resources, etc., with special references to economics, rainfall, hydrography, and forestry. Plates are given of the characteristic fossils and maps of the clays and other minerals. Mr. A. N. Johnson gives his fourth report on the highways of Maryland, with details of road-construction and other matters, as cost and maintenance, of value to local bodies. Mr. E. B. Matthews defines the counties of Maryland, their origin, boundaries, and election districts, and his paper is illustrated by a series of coloured maps. An 8 miles to 1 inch map of the whole State, geologically coloured, is included in an envelope, and on this is also indicated the agricultural soils.

8. Coral Reefs.—In a paper on "Coral Reefs of the Great Barrier,"[1] Queensland, Messrs. C. Hedley and T. G. Taylor remark—"Unhappily for its subject, the controversy upon Coral Reefs has been mainly conducted in cities distant the world's breadth from the scene of investigation. Data compiled for other purposes are pressed into service, and opportunities of verifying facts are denied to authors. Some who discourse learnedly on coral geology have perhaps never touched a living coral." They then proceed to describe in detail three traverses of the Great Barrier Reef, and give the following summary of zones as typical of East Hope Isle:—

	Feet.
1. Living coral rampart	10
2. Living coral (inner zone)	30
3. *Alcyonaria*, etc.	300
Algæ (*Halimeda*, etc.)	600
Islet—Coral sand beach	60
Tree-clad Island	600
Beach and coral rock	60

[1] Adelaide Meeting of Australian Association, held January, 1907.

	Feet.
1. *Chama* beds	300
2. Pseudo-lagoon—(*a*) Sponges	300
(*b*) Mussels, etc.	900
(*c*) *Heliopora*	1500
3. Clinker embankment (broken corals)	30
4. Rock pools	90
5. Outer zone, massive living corals	30

A map and diagrams are given. The authors summarize as follows:—The growth of an individual reef is shown to proceed in a regular cycle. If the reef reaches the surface with its axis along the wind, then its shape endures; but if across the wind, then its extremities are produced backwards, forming first a crescent, later a horseshoe, and lastly an oval, thus enclosing a lagoon. Descent at this stage arrests development or rejuvenates the reef. In quiescence the lagoon walls broaden, the lagoon is obliterated with sediment, a vegetated sandbank spreads on the summit, and the atoll, grown to a cay, has arrived at maturity. 'Negro-heads' are not, as has been advanced, relics of former raised reefs, but masses of coral tossed up by hurricanes, and no great antiquity can be ascribed to them. They find for Darwin's view that this portion of the Great Barrier has been formed during subsidence.

CORRESPONDENCE.

SUMMARY OF PROGRESS.

Sir,—In the review of the Summary of Progress of the Geological Survey for 1907 (August number, p. 379), two rather misleading statements have been inadvertently made which it is desirable to correct. It is stated that the Appendix contains articles "on the Mugearites, one of the Tertiary igneous rocks of the Inner Hebrides," and "on the marine beds near the base of the Upper Carboniferous in Scotland."

The article on the Mugearites was written to describe rocks of this type occurring in the Carboniferous volcanic series in Midlothian and East Lothian. The Tertiary Mugearites, previously recognised and named by Mr. Harker, were only introduced for the sake of comparison. The marine beds referred to occur, not near the base of the Upper Carboniferous in Scotland, but near the base of the Upper Carboniferous red barren measures, which in Scotland overlie all the worked coal-seams of the Coal-measures.

J. Horne.

DESOR'S "SYNOPSIS DES ÉCHINIDES FOSSILES."

Sir,—The "Synopsis des Échinides Fossiles," by E. Desor, is a work still in constant use by every worker on the Echinoidea. Its use, however, is rendered difficult, first, by the lack of an index—a want particularly felt in these days when so many names have been altered; secondly, by the fact that it was published in *livraisons* issued at different dates, and that certain sheets were cancelled, others being substituted at a later date.

I propose, therefore, to publish a double Index to the generic and specific names in the "Synopsis," the names in the first part being arranged alphabetically under the trivial names, while the second part will be an index to generic names, each followed by a list of the species referred to it by Desor. This index will be preceded by a "Note sur les dates de publication," drawn up by Mr. Jules Lambert, who has spent many years in ascertaining all the bibliographic details with regard to this work.

The Index will be printed on paper of the same size as the "Synopsis."

Should there be as many as eighty subscribers, the price may be as low as five shillings.

I shall be glad if intending subscribers will communicate with me at the Natural History Museum, S.W., at an early date, as after publication the price will probably be raised.

F. A. Bather.

THE TYGERBERG ANTICLINE.

Sir,—I regret to have again to refer to this subject, not that I wish to insist that my explanation of the cause for this fold is the correct one, but that I cannot let a fold described by me as an anticline, and shown to be an anticline even in Dr. C. Sandberg's photograph in the Geological Magazine for July, p. 311, be referred to as a syncline. Dr. Sandberg's photograph is taken on the opposite side of the poort to that from which the photograph in Mr. Rogers' "Geology of Cape Colony" is taken, and the real difference is that the south limb of the anticline is cut away and only appears in the background. In the original communication in the Trans. Geol. Soc. S.A., 1906, vol. ix, Dr. Sandberg records that his study of this fold was pursued during a "stay of a few hours off and on" (p. 82), and geologising in a new and unfamiliar country under such conditions is the only excuse Dr. Sandberg can offer for seeing things upside down.

Ernest H. L. Schwarz.

Albany Museum,
Box 13, Grahamstown, Cape Colony.
August 16, 1908.

THE TERM 'CREVASSE.'

Sir,—In several American books on Physiography the term 'crevasse' is employed to designate the gap that is occasionally made in natural or artificial levees. Surely such an employment of the term is to be deprecated, seeing that it has for long been used in another connexion. I have also a faint recollection of having seen it used synonymously with the term 'grike.' There are already too many terms in circulation that are used technically in more than one science. In many cases their usage in the several sciences has obtained such general recognition that it is undesirable to suggest any change, but in such a branch of science as river-development this can scarcely yet be argued. In Holland, where incursions of the sea are not infrequent owing to the breaking down of the artificial levees, the term 'eenbroek' is employed to describe the 'breaking in.' The